Vol. 4 APRIL, 1921 No. 4

Journal

—OF THE—

American Ceramic Society

A Monthly Journal devoted to the Arts and Sciences Related to the Silicate Industries

COMMITTEE ON PUBLICATIONS

EDWARD W. WASHBURN, Editor
Ceramics Bldg., Urbana, Ill.

R. H. MINTON, Chairman,
General Ceramics Co, Metuchen, N. J.

A. V. BLEININGER,
Homer-Laughlin China Co., Newell, W. Va.

H. F. STALEY,
Metal and Thermit Corporation,
120 Broadway, New York

E. W. TILLOTSON,
Mellon Institute, Pittsburgh, Pa.

LE ROY W. ALLISON, Manager Advertising,
170 Roseville Ave., Newark, N. J.

CONTENTS

Page

Editorials:

The Columbus Meeting 259
Does the Society need a General Secretary? 259
Annual Tables of Constants and Numerical Data 262

Original Papers and Discussions:

The Mutual Relations between Art and Technology—Solon 263
An Electric Vitreous Enameling Oven—Mehling and Carpenter 271
The Layout of a Brick or Tile Plant with a Car Tunnel Kiln—Garve 277
Note on the Effect of Time on the Drying Shrinkage of Clays—Geller 282
A Mercury Volumeter—Goodner 288
The Relation between the Fineness and other Properties of Calcined Gypsum—Emley and Welch 301

Ceramic Abstracts 306

Book Reviews 318

Activities of the Society:

Meetings of the Board Held During the Annual Meeting at Columbus. 320
Associates Elevated to Active Membership by Vote of the Board of Trustees at Columbus, Feb. 20 321
New Members Received during February, 1921 322
Minutes of the Third Annual Meeting of the Glass Division, Hotel Deshler, Columbus, Ohio, February 22, 1921 323
Minutes of the Organization Meeting of The Art Division 324

Published Monthly by the
AMERICAN CERAMIC SOCIETY
Publication Office: 211 Church St., Easton, Pa.

Eight Dollars per Year. (Foreign postage additional.) *Single Numbers, Seventy-five Cents*

Entered as second-class matter, July 13, 1918, at the postoffice at Easton, Pa., under the Act of March 3, 1879.

Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized August 16, 1918.

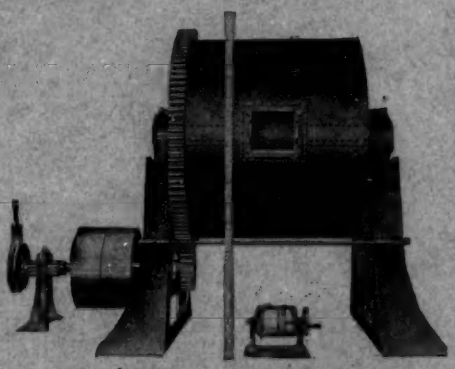
Copyright, 1920, American Ceramic Society

ARE YOU
BALL MILLING
YOUR MATERIAL
SUFFICIENTLY?

USE AN
ABBÉ
ENGINEERING CO.
MILL

A SIZE FOR EVERY NEED
FOR THE LABORATORY OR PLANT

ABBÉ COMBINATION
Laboratory Mill.



ABBÉ PEBBLE MILL (Patented)

ABBÉ ENGINEERING COMPANY

Telephone	1112 St. Paul Building	Works
Cort. 54-55-56	New York	Brooklyn, N. Y.

ANNUAL TABLES OF CONSTANTS AND NUMERICAL DATA, CHEMICAL, PHYSICAL AND TECHNOLOGICAL

Assembled and published by an International Commission acting under the authority of the International Union of Pure and Applied Chemistry.

COMMISSIONERS

Ch. Marie (France), General Secretary; G. Carrara (Italy); Ernst Cohen (Holland); Paul Dutoit (Switzerland); Alfred Egerton (England); E. W. Washburn (U. S. A.).

The publication of the ANNUAL TABLES, which was interrupted during the war, has now been resumed. Subscriptions to Volume IV containing all numerical data published during the years 1913–1916 inclusive will be received *up to May 31* at the special reduced rates indicated below. The edition will be limited, and the price will be raised after May 31.

Advance Subscription Rates for Vol. IV.

(Effective until June 1, 1921)

	Part I only		Parts I and II	
	Bound	Unbound	Bound	Unbound
A. Regular.....	$12.50	11.00	25.00	22.00
B. Special (to members of the American Ceramic Society).....	9.50	8.00	19.00	16.00

Delivery.—Vol. IV is divided into two parts. Part I containing the constants from "Compressibility" to "Electricity" (See Table of Contents, Vol. III) and Part II the remaining constants. Part I will be delivered probably early in July and Part II some months later. Subscribers to both volumes will receive Part I on the July delivery.

Postage and Packing.—Subscribers whose payments accompany their subscriptions will receive the volumes carriage free. To others delivery will be made by C. O. D. express.

Volumes I, II and III.—Orders for these volumes will be received at $7.20 each. Vol. I is, however, not sold separately owing to the limited supply.

(See over)

Volume V.—This volume, covering the years 1917–1920 inclusive, is in preparation and will be ready for distribution late in 1922.

SUBSCRIPTION BLANK

(Cancel what is not required)

Chicago University Press,
Chicago, Ill.

Please enter my subscription for Vol. IV of the ANNUAL TABLES OF CONSTANTS AND NUMERICAL DATA OF CHEMISTRY, PHYSICS AND TECHNOLOGY as indicated below.

Part I Bound. Unbound.
Parts I and II Bound. Unbound.

(*a*) Enclosed find check, money order, draft, for $
(*b*) I agree to pay on receipt of Part I the sum of $ plus carriage charges.
I hereby certify that I am a member of the American Ceramic Society.

Signature.....

Name repeated in print.....

Address.....

.....

.....

Date.....

Fill out and mail to Chicago Univ. Press, Chicago, Ill.

JOURNAL
OF THE
AMERICAN CERAMIC SOCIETY

A monthly journal devoted to the arts and sciences related to the silicate industries.

Vol. 4 **April, 1921** **No. 4**

EDITORIAL

THE COLUMBUS MEETING

All members who attended the twenty-third annual meeting of the Society on February 21–24, were impressed with the wonderful growth of the organization and its rapid expansion into new fields of endeavor. With a record-breaking attendance of over four hundred members, seven professional divisions met for the reading and discussion of technical papers. The local committee under the chairmanship of Professor Arthur S. Watts, ably seconded by Mrs. Watts, had made every provision for the comfort and entertainment of the visiting members and their guests. The meeting was a memorable one, also, because of the return of Col. Edward Orton to the fold. A full account of the meeting together with President Minton's address and the proceedings of the Society and of the Divisions will appear in the Year Book.

DOES THE SOCIETY NEED A GENERAL SECRETARY?

The objects of the American Ceramic Society are to "develop the ceramic arts and the sciences related to the silicate industries by means of meetings for the reading and discussion of papers, publication of scientific literature, and other activities." The objects of the Divisions or professional groups must be the same as those of the society. The order in which the "objects" are listed in the "Rules" of the society is somewhat historical. When there were only a few interested in ceramic technology; when the literature was scant and there was no Federal Bureau and only

two Universities doing ceramic work, the principal objects of the society were: (1) meeting together; and (2) publication. The last object, "other activities," possibly was added to care for future developments.

With changing requirements caused by largely increased numbers of technically trained ceramic workers, by more literature, and by the activities of Federal Bureaus and Universities, the American Ceramic Society is now compelled to take up "other activities" as a prime object.

There is obvious significance in, and a natural consequence to, the forming of separate associations by the several industrial groups. Manufacturers have learned the futility of organizations having only general objects. They realize the advantages of coöperation, for definite purposes, with those in the same line of manufacturing. One of the natural consequences of this joining together of manufacturers in coöperative enterprises is the financing, in a large way, of technical investigations. The American Ceramic Society is the only organization whose single object is the promotion and publication of research in the science and technology of ceramics, and to this single purpose the Society has kept and must keep steadfast, and in this manner and for this purpose invite the respect of the manufacturers' associations.

In the early years when the members were few and ceramic technology almost in its beginning, there was no demand for specialization, but as membership in our society grew in numbers and the science developed, it was found necessary to create professional Divisions to the end that each group might have the opportunity for more thorough and intensive consideration of problems of particular interest to itself. This, however, has not fully met the requirements. If the American Ceramic Society is to meet its full obligations, it must consider as the most important of its "other activities," that of stimulating and providing direction for coöperative research through the agency of the professional Divisions.

Experience has shown that a Division can not be created or successfully maintained unless one of the main objects of the Division is coöperative research. Thus Divisions for whitewares, refractories, heavy clay products and abrasives have in the past

been either non-existent or unprogressive because no organizing effort has been made to stimulate and direct research in these particular fields. On the other hand, the terra cotta, glass, and enameling Divisions have prospered to the extent of their attention to coöperative investigations. The new Art Division has promise of success for it is being builded on a program in which meeting together and publication are only incidental.

The American Ceramic Society must make provision to meet the requirements of the manufacturers' associations or fail utterly in maintaining one of its avowed objects. Most of the manufacturers' associations have indicated their willingness and desire to finance technical investigations under the auspices of a Division provided the Society is prepared to furnish the necessary expert direction. The advantages to be obtained by manufacturers' associations placing the prosecution of their technical investigations with the Divisions of the American Ceramic Society are evident. Although the ceramic industries differ widely in many respects, each having much that is peculiar to itself, there is so much more that is common to all, especially in things technical, that the "ceramic arts and sciences" will advance more surely and more speedily, if all are kept united in one society.

Our society can, however, no longer continue to progress, solely by meeting together in conventions and by publishing technical literature. To do just that and that alone was a big undertaking twenty years ago but the very progress in ceramic technology resulting from these early meetings and publications has brought about widely different conditions today. The requirements of today must be cared for today and there is none more pressing than coöperative research in specialized divisions of "ceramic arts and sciences." The life of the Divisions will be the life of the Society and the failures of the Divisions will be the failures of the Society; and experience has demonstrated that the life and success of the Divisions is dependent upon the extent to which their numbers unite on coöperative research.

The organizing of new divisions, the maintenance of the necessary degree of coöperation among the various divisions, and the establishment and maintenance of relations with other organizations, together make up a field of labor requiring the full time and

energy of a General Secretary. The duties of such an officer would be quite apart from and in addition to those of a Recording Secretary and would be more in the nature of those which would be expected from a president whose tenure of office was permanent and who devoted all of his time to the work. Such an official would necessarily work in close coöperation with the President of the Society and would insure continuity of effort through changing administrations. It is important that the society give immediate attention to the matter of employing a full time General Secretary.

Ross C. Purdy

ANNUAL TABLES OF CONSTANTS AND NUMERICAL DATA

By virtue of its membership in the Division of Chemistry and Chemical Technology of the National Research Council the American Ceramic Society is also a member of the International Union of Pure and Applied Chemistry and is privileged to nominate a delegate to each annual meeting of the Union. One of the international projects for which the Union is responsible, is the collection and codification of all scientific data, expressed in numerical form, which have been published in the literature of the world in every calendar year. The data cover chemical, physical, ceramic and technological constants of all kinds and the annual volumes published by the commission are indispensible to every worker and to every organization using data of this character since they eliminate the enormous labor of searching the world's literature in order to find the latest figures for a given property of some material.

The publication of the annual Tables was interrupted by the war but the organization was held together by its efficient secretary, Dr. Ch. Marie, of Paris, and after some reconstruction is now functioning once more. On page one of this issue we publish an announcement regarding the new volume, now in press, which will contain all data published during the years 1913–1916, inclusive. This is the first volume to appear since the beginning of the war.

ORIGINAL PAPERS AND DISCUSSIONS

THE MUTUAL RELATIONS BETWEEN ART AND TECHNOLOGY[1]

By Leon V. Solon

Abstract

An analysis of the purpose of decoration and of the characteristics of bodies, colors and glazes which determine their acceptability for the purposes of the professional decorative artist. The author urges the establishment of an Annual Exhibition where American ceramic artists may exhibit their products along side those of the sculptors, mural painters and other artists.

With the recent institution of a decorative art section in this Society, which is to occupy itself with matters appertaining to artistic progress, a new responsibility must be borne by each, be he a chemist, technician or artist, if this country is to add a worthy chapter to the brilliant history of our craft. This recognition of artistic activity as a subject of general interest for our membership, has been tardy, possibly, for the reason that achievement in that direction has not compelled interest of recent years. Be that as it may; where results of the highest order depend upon a perfect adjustment of contributory effort (as they do in ceramics), the two main contributory activities, the technical and the artistic, can not advantageously develop apart; it is therefore essential, to define in a general way, the mutual relation of arts and technology, and to locate vital points of contact. I have attempted to discover where energy is lost through lack of comprehension of what the decorative sense seeks in certain technical achievements; and to draw attention to certain professional view-

[1] Received March 5, 1921.

points of the decorative artist which determine the acceptability of bodies, colors and textures.

Beauty in any art, whether a fine or a decorative art, is realized in a measure through the development of the characteristic. In our art, the characteristic finds its clearer expression in plasticity, texture, and color quality, all of which are now only available as media of effect in such form as the technician produces them. The artist conceives an effect and is stimulated to a higher degree of attainment, or restricted in execution, proportionately to the adequacy or inadequacy of the technician's efforts. A technician who contrives any accessory without acquainting himself with the function it is to perform, is adopting the unscientific procedure of taking shots at a venture; yet unlimited instances can be cited in our industry where bodies and glazes are produced under precisely such circumstances. For that reason, if scientific effort is to realize its maximum decorative utility, the technician must direct his energy, and plan procedure, with a clear comprehension of those artistic standards by which his labor will be judged fruitful, or discarded as useless.

Ceramics, in common with all industrial arts, consists of two distinct but interrelated activities; the first of these, if we accord procedence in the order of evolution, concerns itself with the lower purpose, the utilitarian; the second, while recognizing the original incentive, is directed to investing the useful with beauty, as a major objective far surpassing the creation of convenient devises for mundane requirements.

Modern civilization has evolved obvious economic problems as a result of complex circumstances; for many years the energy and ingenuity of the technician have been almost exclusively concentrated on their solution. Far-reaching research and perfection of method in production have achieved the remarkable result that, in many branches of the industry, technical excellence exists as a matter of course, which none can afford to claim as a distinction; for the reason that it exists in the achievement of many. At this stage of progress, pre-eminence must be sought along a different path. The mechanical standard of faultless uniformity must be relegated to a place of secondary importance in an essentially commercial class ruled by competitive price;

in the first rank superiority will exist in aesthetic quality, evidenced in treatment. By treatment I do not mean the development of decorative expression alone, but include in that term the manipulation of such factors as texture and color in body and glaze, with the direct intent of stimulating intellectual processes, and creating forms of sense-appeal that are aesthetic by nature.

With this higher and more spiritual objective, all that which bears upon standardization or industrial economics, must naturally gravitate to the sphere of routine; the fortunate few who are endowed with the rare gift of aesthetic discernment, will enter a field where their achievement will be recorded in history and their handicraft be preserved as milestones on the road of progress.

Some may inquire as to the way in which the uninitiated may seek this new objective. The chemist, for instance, who is proficient in the creation of colors for decorative purposes, may have doubts as to whether his untutored chromatic sense is adequate to guide him to the limit of his capacity. Unfortunately, at the present time, decorative proficiency in the ceramic industry, of this and other countries, is far behind technical achievement; with the result, that there is no great progressive artistic movement which might be observed with the purpose of regulating scientific research in a clearly indicated direction, so that obvious decorative requirements might be anticipated by the technician. The indication is, that decorative ceramic development will, in the near future, be subordinate to the leadership in stylistic treatment of other more progressive crafts. By this I mean, that the decorative artist or architect who carries out the interior finish of a house, will encourage the purchase of such ornamental or dinner ware, or tile, as conforms to the prevailing vogue in treatment; and that the ceramic designer who disregards such preferences, sidetracks his product. The same condition exists in faience and terra-cotta; those designers in factories who are out of touch with the rapid exchange of preferences which are succeeding each other in architecture in our day, hold their product back to those markets where the minimum price has the maximum chance. What is the actual condition of our industry today, in those types of products where artistic quality in technique and treatment means more than cheapness? How does it appear from the

vital angle, the angle from which it is viewed by men whose approval can give it rank among the progressive industrial arts? Let us assume a hypothetical case: A man of prominence and distinguished attainment in the decorative arts is attracted to our craft by the desire to create effects as beautiful as those that fascinate him in historic ceramics. His first step will be to pass in review all that is available for decorative effect in current production, in pigment and texture. His initial impression will undoubtedly be, that the aspirations and ideals of those who create the media of effect, differ radically from those of the men who use those media, to produce the ultimate effect. The artist in selecting a group of pigments to create that entity of effect which is known as a "color harmony," seeks certain chromatic factors in the colors selected, which are the connecting links between color units. Those chromatic factors in colors, which I will describe as "common tone factors," exist between varying and different tints; these are of secondary importance if judged by their radiant energy, but are of vital importance in the establishment of mutual relations between color units assembled in groups for artistic effect. This factor which the decorative artist urgently needs to facilitate chromatic adjustment, and to add subtlety to character, is ignored by our color-makers and is encountered with just sufficient accidental frequency to prove that absence is due to non-perception, rather than to technical obstacles.

A further examination will reveal the fact, that the ceramic chemist's work in color is a series of separate and unrelated units, made without regard to characteristic color qualities capable of group formation, though he is quite conscious that the isolated color in decoration is not the prevailing method of use. The idea of creating palettes with a prevailing tonal relation does not appear to influence the majority of color-makers. The individual preference of most color-makers is to make colors of the intensest purity, carefully eliminating those underlying tones which the decorative colorist seeks first. That underlying tone in a composite color, is comparatively inactive, until placed alongside another composite possessing a tone element that corresponds to it; the affinity in those underlying tones constituting a relationship between the composite tones of a harmonious nature. There

are certain glazes I have in mind, which alone would be described as nondescript and lacking in individuality; but which, when included in a group of colors having a tonal relation to them, assume a quality of the greatest subtlety and beauty. Such tones would in all probability be rejected by the majority of technicians as failures, through lack of appreciation of their function in harmony and their decorative value. The prevailing inclination of the chemist for the maximum degree of radiant energy and tint purity, meets only the exceptional need of the decorative colorist. Such colors in the majority of cases could serve only as accents in an adjusted color group; the result of a group of units each with a distinct power for emphasis, is as unacceptable as over-emphasized music, action or speech. I would recommend that color-makers practice a new species of observation, which would be cultivated by placing colors alongside in pairs, in order that eye and brain be activated to detect the mutual affinity, repulsion and reaction of each upon the other. By the development of a sense of this description, results will be achieved by those whose temperament permits such notation, which will economize effort and contribute to artistic progress.

There is another extremely important point of observation to be developed in glaze making, which is one from which the decorative colorist judges the artistic value of a glaze: I refer to quality of texture. Texture is estimated by the artist from an entirely different standpoint from that of the technician; the former judges visually, the latter by touch. Texture in the artist's brain is indicated by the degree to which surface absorbs light rays, or reflects them. Variation in qualities of decorative effect demand a range of textures to be met by various surfaces, with the maximum degree of reflection and absorption as the two extremes. In the light-absorbing type, the area of intensest illumination is greater, lower in tone, and less scintillant than in the reverse class, a distinctive tone quality characterizes each type. If a constant study were pursued by technicians, to note the reaction of color to light, in accordance to its capacity for absorption or reflection, the great importance of this point of view in guiding color production can not fail to impress itself upon every observer.

I believe that at the present time technical achievement in

ceramics equals the total of experience in all ages; how is it that this vast fund of information is unrewarded with due credit, and its existence unsuspected by the art world or general public? Why is it that beautiful laboratory specimens of colors, which equal and often surpass their historic prototypes, should not enjoy a corresponding aesthetic prestige? The reason is simple and obvious. Individually, each is a unit of decorative effect, in the same manner that a musical sound is a unit of musical effect, and a numeral a mathematical unit. Such units possess interest only through the mental process of association, when placed in combination with other units of their kind; in the case of chromatic tone, or musical tone, the beauty of the unit is relative to the character of sense appeal, or imagination, that is stimulated through the manner in which it is associated in effect. For this reason the laboratory achievement, without decorative interest, can only possess a technical interest, and be enjoyed solely from a scientific standpoint; such limitation in appreciation excludes that class of individual for which the effort was originally undertaken. Can it therefore be maintained that the aesthetic objective in technical endeavor is a matter secondary or of negligible importance to the technician?

This consideration leads us to another serious question: How is adequate decorative quality to be developed? It is my conviction, resulting from an abundance of signs, and unmistakable evidence, that the United States will, during the coming century, lead all other nations in the decorative arts. In decorative metalworking already, particularly in wrought iron and bronze casting, the highest achievements of Europe are out-distanced. The most intricate weaves of Italy, Spain and France possess no difficulties that the American weaver can not master and reproduce; they are now seeking their individual form of art expression, which they will undoubtedly find. Furniture also is making astounding progress in technique and treatment. In every instance, progress is the result of the clearsightedness of manufacturers, whose ambition to excel in their crafts caused the commercial standards of mechanical excellence to rank in their estimation as little better than mediocrities. In what manner can we revitalize our craft, that it may achieve beauty in the eyes of those whose high stand-

ards makes their approval a hall-mark of merit? The old method, which staked all on manual training, will not suffice today, and the demand for superior achievement is too urgent to put off meeting it until the next generation matures. The demand of the American public, the most discriminating of our time, can not be met by a mechanical training of young men and women to laboriously reproduce Sevres or Crown Derby; factory-hacks can not bring our industry on a par with others in which every effort is strained to attract versatile talent capable of developing vital energy from historic tradition. If we rely solely on factory tuition or technical schools conducted on similar lines, we will fail to emerge from mediocrity, for the reason that the spontaneous decorative expression which characterizes all historic styles, is only recognized there in the idiosyncracies found in the confirmation of decorative detail. The means for worthy artistic achievement are to our hand today if we care to avail ourselves. Let those members of this society who see the need for new life in American ceramics, group themselves together annually under the auspices of some such progressive society as the Architectural League of New York. At the annual League exhibition, where the best of other crafts is gathered together, let the Ceramic Society show the American sculptor, the mural painter and the American art world generally, that our technicians have produced media for beauty which can equal that of any historic period. I have had very many conversations with men foremost in the ranks of the various branches of high and of applied art in this country who long for the beauties of ceramic color in their works; such men are ready to respond to your call, and to create beauty with what are now but formulae. The expense involved in retaining or employing prominent American artists, convinced as they are of the possibilities, is trifling when set beside the prestige that would accrue from success—and as business men we need not be reminded of the cash value of prestige. Next year members of the society should be represented at the League Exhibition in association with distinguished American artists, and the naissance of American Ceramic Art should be recorded in the future histories of our craft.

The public has clearly shown its impatience with commercial

standards and its boredom with mere technical excellence; it wants *treatment*, and for a time has lavished enthusiasm in protest on the mishandling of clay by the peasant potter. When a premium is placed upon lack of technique by a highly educated class, as in this case, we must record deduction from an unmistakable sign, and alter our course. The present and future credit of American Ceramics depends upon an infusion of new blood; let the art world supply the red corpuscles.

16 E. 41 St.
New York

AN ELECTRIC VITREOUS ENAMELING OVEN[1]

C. W. Mehling and Jas. W. Carpenter

ABSTRACT

Comparison with older types of furnaces.—In marked contrast with the oil, coal and gas furnaces the electric furnace eliminates damaged ware and makes possible the utilization of the entire heating space. Its initial cost and the fuel costs are double those of the older types but it admits 25 per cent increase in weight per charge and 30 per cent in charges per hour.

Description and operation.—Details of construction are given. The electrical equipment is explained together with the methods of temperature record and control. Details of operation are given.

Cost of operation.—With an initial cost of $8000, the cost of the electrical power has been $2.00 per hour for a 10-hr. day which would be reduced to $1.56 per hr. for a 24-hr. day.

Production results.—With a production of 900 lbs. of ware per hr. the enamel finish is more satisfactory than with the older types of furnaces.

Future improvements.—Preheating chambers and double end operation are suggested.

One of the most momentous improvements of recent years in the art of vitreous enameling has been the application of the electric furnace to the heating process. The use of electric current for heating in the steel and in non-ferrous furnaces, in japanning, core baking, oil tempering and similar industrial operations has now been extended to the enameling process.

Brief reference may be made to the disadvantages and troubles which have been encountered in the operation of the older methods of obtaining the temperatures (1500° to 1800°F.) required for satisfactory enameling work. With regard to the coal furnace it may be pointed out that in order to maintain the temperature of 1700°F. it is necessary to employ an expert fireman and there are even then times when atmospheric conditions make it impossible, even with the very best of firing, to procure and maintain this constant temperature. The most serious defect in the coal furnace is the muffle which periodically sags and breaks, thereby

[1] Received Feb. 23, 1921.

causing damage to or loss of ware by allowing the rack rests to go down and regularly at intervals of from two to twelve months it is necessary to renew the muffle and overhaul the fire-box and furnace. This usually means a shut down and loss of production for from two to four weeks. Moreover, in the coal furnace the sulfur fumes which are injurious to the ware and frequently cause a high percentage of seconds or of job lots are so difficult to eliminate that a certain factor in production must ordinarily be allowed for the damaged output which will be obtained from the ordinary furnace.

The oil furnace and the gas furnace have the same draw backs as the coal furnace. They will not hold the heat in burning large ware and the bottom of the muffle burns out even faster than it does in the coal furnace. Likewise, the great variation in temperature between the front and rear ends of the oven usually reduces the actual space which may be productively used in burning. Such ovens are handicapped by the time required to bring them from a cold condition to operating temperature, and part time operation is practically impossible. Also the fuel supply for coal and oil furnaces is dependent upon railroad and labor factors which are not entirely dependable. The space occupied by the older ovens is greatly increased by the fuel storage room needed.

In sharp distinction from the preceding faults of the older type furnaces it may be indicated that in the electric furnace there is no trouble with the muffle and the consequent loss of ware by falling rack rests since the electric furnace has no muffle and the rack rest is built right up from the foundation. Furthermore, the even distribution of heat is a feature which can be obtained only by the electric installation and the furnace can be loaded from the rear wall right up to within six inches of the door and burned down to a finish, the operation giving a clean white enamel without spot or mar. Atmospheric conditions of course have no influence upon the electric furnace as it needs no draft.

The initial cost of the electric furnace is of course considerably higher than any of the other types, but the difference in maintenance cost, the saving in space, and the cleanliness soon make the difference in price a matter of secondary importance. The fuel cost on an hourly basis for the electric oven is likewise higher,

running nearly double that of coal, gas, and fuel oil for twenty-four hour day operation. However, the additional output of the electric furnace as determined by relative tests shows that the actual cost per pound of metal handled will compare very favorably with any other form of fuel. When the electric furnace is able to handle in ten hours at least 170 heats of No. 22 gauge steel against 130 heats of the same material by the coal furnace, and with 25 per cent greater weight per charge, the comparison in actual cost of fuel assumes a different aspect and is actually in favor of the electric installation.

The oven in which we are interested is the first commercial installation of such an equipment in the United States, and has been installed within the past six months in the factory of the St. Louis Brass Mfg. Company at 2615 Washington Ave., St. Louis. The installation was made under the direct supervision of Mr. E. F. Guth, President of the St. Louis Brass Mfg. Company, and the record established thus far has fully justified him in the adoption of this method of furnace heating.

The furnace measures approximately 12 feet 11 inches in depth by 7 feet 8 inches in width and 7 feet 4 inches in height in overall dimensions. The actual enameling space is 4 feet wide by 2 feet high by 10 feet deep. The heat is obtained from nichrome ribbon woven up and down on each side of the furnace over special hanger brick in a lattice like arrangement. The winding on the lower sides is double while that on the upper sides is single except for about 22 inches back of the door where a double winding is installed to make proper allowance for the escape of heat when the door is opened and closed for loading and unloading. The nichrome ribbon is approximately 5/8 inch wide and 0.05 inch thick. There are six heating elements in the furnace and micrometer tests made after sixty days operation showed no physical change in the windings. Similar nichrome elements for heat treating, etc., have been in use for over three years without apparent change.

The furnace brick work is built up in the following fashion: There is first a four inch course of common fire-brick and the special hanger brick for the support of the heating elements are incorporated as a single row in this course. Outside the fire-brick there

is a 9 inch course of insulating brick and then a 4 inch course of common red brick. It is proposed to cover the entire furnace with a coat of asbestos from two to four inches thick. The door is about $4^1/_2$ feet wide by 3 feet high and is made of insulation brick and steel frame. As far as possible special monel metal racks are used in carrying the heating work to reduce the area and weight of supporting metal and prolong the life of the racks.

The electrical equipment for the furnace consists of the ribbon windings which have a minimum rating of 150 Kilowatts or roughly 200 H. P., and are operated on 230 volt, 3 phase, 60 cycle current and protected by special fuses. An automatic electric control panel containing contractors and automatic switches provides automatic record and control of the temperature of furnace. The record chart shows the temperatures of both the ribbon and the air and the furnace can be operated continuously at any temperature up to 1800°F. The nichrome windings in the furnace are connected to the control apparatus and to the transformer substation by heavy copper wire installed in conduit and the entire oven installation is on a separate oil switch which gives it individual control independent of the lighting and power load of the factory.

Guarantees of performance of the furnace were given at the time of installation as follows:

1. The oven will bake eight pounds of material per kilowatt hour including racks which are figured on the basis of one-half of above weight, when oven is operating at full capacity of 1200 pounds of material per hour including racks.

2. The electric heaters will maintain continuously a temperature of 1700°F. under an operating cycle of 3 minutes and 40 seconds, door open 10 seconds to load and open 10 seconds to unload with average bake of 3 minutes and 20 seconds.

3. The maximum demand of the heating unit will not exceed 150 kilowatts..

The cost of the furnace approximates $8,000.00 consisting of about $4,000.00 for the nichrome windings, hanger brick and electrical control equipment, $800.00 for electric wiring and material, $1500.00 for oven construction, and $1900.00 for transformer capacity and substation expense. For certain installations

this expense would of course be increased, if the electric furnace were the only electrical equipment installed, as in that case the total substation cost would be placed entirely upon the furnace. For two or more ovens the substation cost would be divided and the net first cost per oven would be reduced. At the present time the St. Louis Brass Mfg. Company furnace is being operated only on a night shift and the cost has approximated $2.00 an hour with an average hourly consumption of 125 kilowatts. For a 24 hour day operation and the consequent reduction in overhead expense, the cost for current would be about $1^1/_4$ c. per kilowatt hour, giving an hourly cost for the furnace of $1.56.

The results thus far obtained have been highly satisfactory, particularly with regard to the quality of the output and the speed with which the oven can be brought to temperature, 1700°F. being reached in 12 hours. To reach this temperature with a coal furnace would require up to 48 hours, with oil or gas furnace, about 24 hours. The electric furnace has been cut out at 5 A.M. with temperature at 1700° and cut in again at 6 P.M. at 1200° and in forty minutes it has been ready for work at 1600°. The production per hour is 2338 pounds of ware and racks, with 130 kilowatts per hour, the number of charges being 24. This means 900 pounds of enamel ware at a cost of $2.00 for the electric energy.

The outstanding features of the oven have been the extreme speed at which it can be operated, the cleanliness and improved appearance of the enameling room, and the absence of rejected pieces through improper burning or damage from fumes or soot. The most pleasing feature of the oven has been the finish on the ware as it has been far superior to the bake obtained in any other way.

Future installations of this nature can probably take advantage of facts learned in the use of the present furnace and it is probable that other ovens to be constructed will include a preheating chamber where the temperature will be kept at from 800 to 900°F. and there are possibilities of a double end furnace so that work can be fed in at one end and removed at the other, thereby greatly increasing the speed and amount of metal baked.

In the installation as thus far operated the results predicted for electric heat in this work have been fully demonstrated and the

many advantages of electric heat for enameling as well as for the many other purposes to which it is being adapted have been fully justified, and it seems quite apparent that there is a wide field for the application of electric heat in the enameling industry.

ST. LOUIS BRASS CO.
AND
UNION ELECTRIC LIGHT & POWER CO.
ST. LOUIS, MO.

THE LAYOUT OF A BRICK OR TILE PLANT WITH A CAR TUNNEL KILN.[1]

By T. W. Garve

Description of a hollow tile and drain tile plant using a tunnel kiln. The routing of the material (shale) and product is described under the following heads: dump cars, plate feeder and crusher, storage, dry pans, screens, storage, pug mill and tile machine, combination waste heat and radiated heat drier, kiln car loading station, tunnel kiln, kiln car unloading station, stock shed. A detailed diagram is given.

It is but very recently that car tunnel kilns have been seriously considered in this country for burning common clay wares such as brick and tile.

It would seem at a first glance that the long stretch of a tunnel would not fit well into a satisfactory layout of a brick plant. As a matter of fact, however, quite a satisfactory arrangement can be worked out with a tunnel kiln for a plant of average capacity. For larger plants with several kilns it is necessary to give a good deal of study to the track arrangement in order to avoid congestion in certain places. The burning of the common clay wares in a tunnel kiln is one problem and the handling of the ware is another equally important problem.

In plants producing high priced products such as sanitary ware, table ware, and pottery, it is to a great extent the quality of the ware that pays the interest on the investment and yields the profit, while on a common ware plant the output will usually be the important factor. The car burden in a pottery represents a value which would be expressed in three figures, while in a brick or tile plant the car may be worth ten to fifteen times as much as the ware.

In a plant manufacturing common ware with a car tunnel kiln it is important that labor be reduced to a minimum and hence

[1] Received February 15, 1921. Presented at the Columbus meeting of the Society, February, 1921.

automatic operation must be utilized as far as possible. The loaded as well as the empty cars, being heavy for this kind of ware and output, can not be conveyed by hand, and proper car moving devices must be installed.

The car tunnel kiln introduces a new and different system of brick making. Such a plant has to be operated continuously, and more skillful labor is required than was customary on the old type "brick yard." One of the advantages of the tunnel kiln, or continuous kiln is that it makes continuity of plant operation imperative and eliminates excuses for frequent shut-downs.

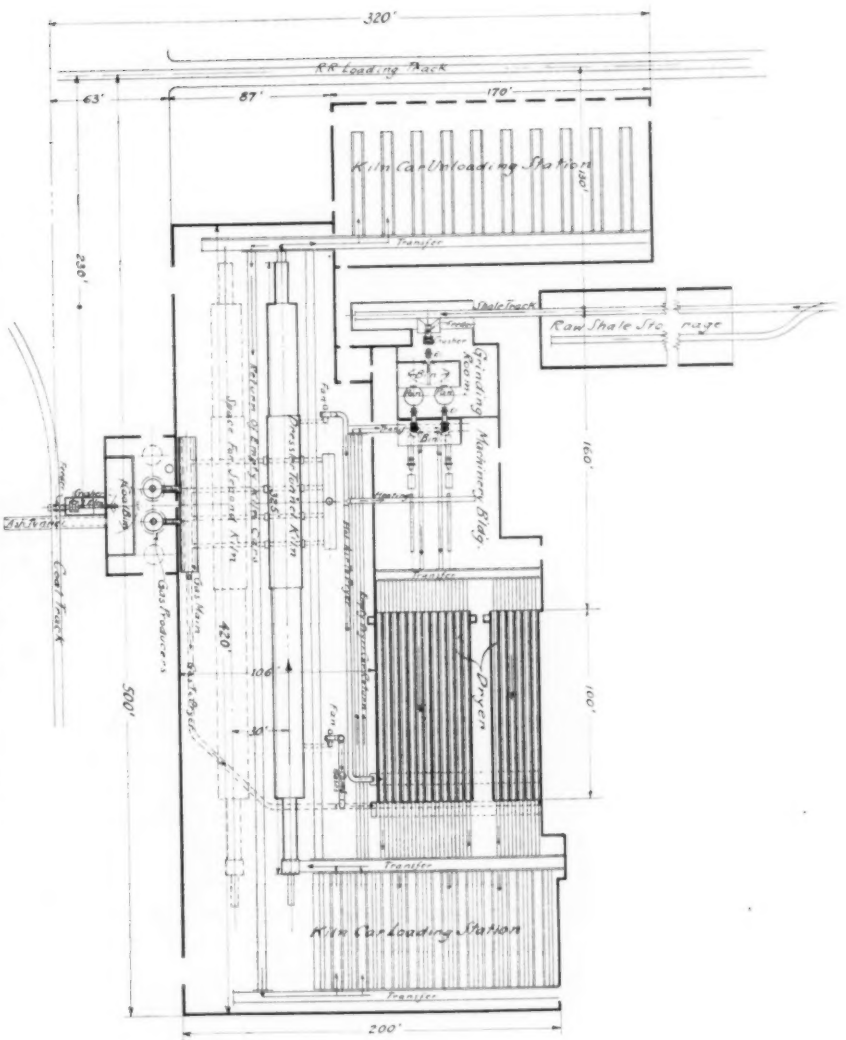
The Franklin Brick & Tile Company of this city is completing a plant for making hollow building tile and drain tile with a Dressler tunnel kiln, at Taylor Station, nine miles east of Columbus. The illustration gives the outlines of this plant with the exception of the raw clay storage building not yet constructed.

The shale is hauled up in side dump cars by a gasoline engine and dumped into a pocket above a plate feeder and crusher. One advantage of a plate feeder is its insurance against accidents, since a man, should he fall into the hopper, will have ample time to climb out unharmed.

The crushed shale is elevated, stored and fed to ten-foot dry pans with gravity hopper bottom. The ground shale is then elevated, screened, stored, and fed to the pug mill and tile machine.

The grinding room is dust proof and arranged so that one man is able to look after it, even for a capacity of 200 tons a day.

The drier is a combination of a waste heat and a radiated heat drier using the hot air from the cooling end of kiln, the combustion gases from the kiln, or producer gas from the gas main. If there is sufficient waste heat from the cooling ware, the drier may be operated as a waste heat progressive drier, but lacking sufficient hot air, the latter may be supplemented by waste gases introduced into the drier through the producer gas burners. It will be understood that the hot air is introduced among the pieces of ware as in a waste heat drier, but the combustion gases are confined to the radiated heat duct. In winter it is proposed to use the hot air from the cooling ware for factory heating, and in the event that the combustion gases alone do not give sufficient heat for



The layout of a brick or tile plant with a car-tunnel kiln.

drying, we can resort entirely to producer gas and the operation of the drier is simply that of a producer-gas fired radiated heat drier.

After passage through the drier, the cars are taken to the "kiln car loading station" which has depressed tracks for the kiln cars between the drier car tracks. From here each loaded kiln car is by transfer taken into the kiln. Each car will have to carry about two and one-third tons of ware, and to maintain the estimated capacity, a car must be introduced about every 33 minutes.

The cars are taken out at the other end of kiln and transferred to the "kiln car unloading station." The kiln car tracks here are also depressed to make the handling easier and quicker. An electric lifting truck operating on platforms between these tracks takes the ware directly into the railroad cars or stock shed.

Alongside the kiln a track is provided for returning the empty kiln cars from the unloading to the loading station. The empty drier cars are returned on tracks inside the kiln building along the drier.

The kiln is guaranteed to burn 100 tons of hollow ware per day, but space has been left for a second kiln and two more gas producers, and tracks and drier can be extended if necessary.

There are two railroad switches, branches of a Y, one being a loading track and the other a coaling track. The coaling station in front of the gas producers consists of a plate feeder below the track, a coal crusher in a pit, an inclined elevator with swivel spout and a large coal bin in front of the producers. The power throughout the plant is electric and, with a few exceptions, the drives are noiseless chains from individual motors.

The kiln car loading station was necessary in order to keep the kiln supplied during the night and over Sunday, and for the same reason the kiln car unloading station had to be provided to take temporary care of the cars taken from the kiln during the night and on Sundays. This requires 66 kiln cars exclusive of the 44 cars in the kiln. The number of extra cars can be reduced, if night shifts are employed in loading, unloading, and transferring.

It might be possible to eliminate the second handling, namely, the transferring of the green ware from the drier cars to the kiln

cars, thus eliminating the kiln car loading station. If the kiln cars could be loaded at the machine with their full capacity, and if they could be shifted, dried, and burned without damage to the ware, we could substitute a tunnel drier for the kiln car loading station from which the cars are taken at the intervals necessary for feeding them into the kiln.

NOTE ON THE EFFECT OF TIME ON THE DRYING SHRINKAGE OF CLAYS[1]

By R. F. Geller

ABSTRACT

The drying shrinkage of clays were studied to determine how quickly different types can be dried and to note whether or not the time of drying influences the amount of shrinkage. Three shales, two ball clays and one fire-clay were tested and the following conclusions reached: (*a*), drying time depends largely on water content; (*b*), the structure of the clay is an important factor; (*c*), the amount of total shrinkage is proportional to the water content; (*d*), the amount of total shrinkage is not influenced by the rapidity of drying.

The primary object of this work was to find how quickly different types of clays can be dried and incidentally to find whether or not the rate of drying influences the amount of shrinkage.

Three types of clays were studied: three shales, two ball clays, and one fire-clay. Each of these clays was pugged thoroughly to good working consistency, wedged by hand and made up into two inch cubes by pressing into brass molds. From each clay 48 specimens were made, six being used in each drying experiment. The average values from each set were used in computing the results.

Immediately after they were made, the specimens were weighed in air, placed in kerosene for 24 hours, and the weights again determined both in air and suspended in kerosene. The specimens were then placed in an electrically heated oven whose temperature was determined by means of a thermocouple connected to a recording potentiometer. The drying consisted in bringing the clay cubes from room temperature to 100°C. along a straight line time-temperature curve. The length of each drying period varied from 1 to 8 hours.

The samples when removed from the dryer were at once im-

[1] Received Feb. 14, 1921. Published by permission of the Director, Bureau of Standards.

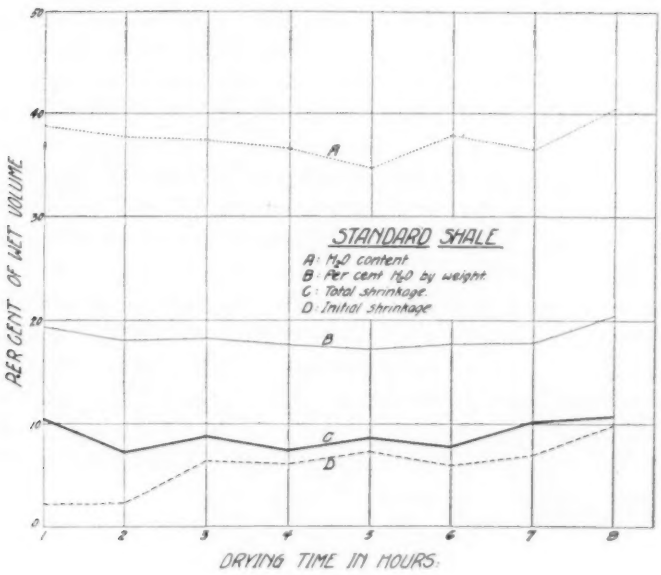

PER CENT OF WET VOLUME
DRYING TIME IN HOURS
STANDARD SHALE
A: H2O content
B: Per cent H2O by weight
C: Total shrinkage
D: Initial shrinkage
A
B
C
D

FIG. 1.

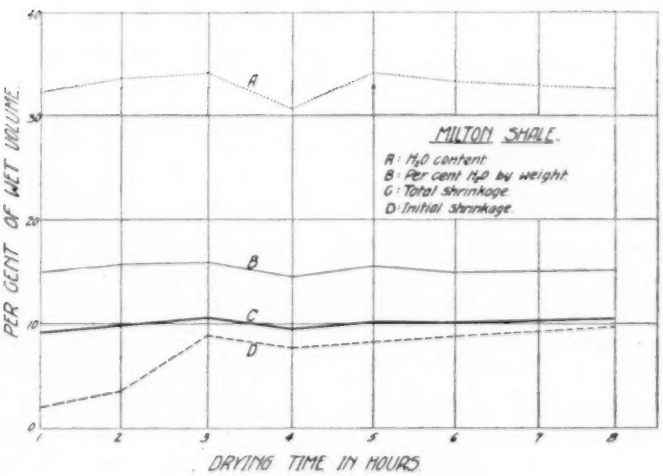

PER CENT OF WET VOLUME
DRYING TIME IN HOURS
MILTON SHALE
A: H2O content
B: Per cent H2O by weight
C: Total shrinkage
D: Initial shrinkage
A
B
C
D

FIG. 2.

mersed in kerosene for 24 hours and their weights, in air and suspended in kerosene, again taken. From these values the volume shrinkages were computed. The total shrinkage of three samples from each set of six was likewise determined by heating them to constant weight at 110°C., the volumes being again computed from the weights in air and suspended in petroleum. All shrinkage measurements were based on the volume of the specimens in the plastic state. The results of this work are shown graphically in the diagrams of figures 1 to 6. Each diagram consists of four curves of which A represents the water content of the specimens in terms of the wet volume, B the weight of water in terms of the wet weight, C the total shrinkage in terms of the wet volume (obtained by heating the clay to 110°C.), and D the shrinkage determined at the end of the several periods. Figures 1, 2 and 3 represent three shales and we observe that in each case the partial shrinkage parallels the total shrinkage after four hours drying. In no case, however, do the two curves coincide, although in the the diagram of figure 3 they approach each other very closely.

The constant variation noted in the longer drying periods is due in part to the small shrinkage taking place between 100° and 110°C., it being borne in mind that the first drying was carried just to 100°C. and the complete drying to 110°C. There is a tendency for the curves C and D to coincide for longer periods, which is to be expected. One should expect that the minimum drying time allowable in practice for pieces corresponding to the size employed in this work would be represented by that point at which the two curves first coincide. Such a point is not reached in these curves, but they approach each other closely enough to warrant the statement that, theoretically speaking, shales could be dried in four hours, provided the heat treatment corresponded to the one used in this work, and likewise provided that the steam were removed promptly from the drying chamber to avoid possible reabsorption. Of the three shales, that from Ridgeway seems to show the fastest rate of drying. It is evident that shales as a class should show a more rapid capillary water movement than the more plastic materials.

Figures 4 and 5 give the curves obtained with two ball clays, the former representing an English and the latter an American

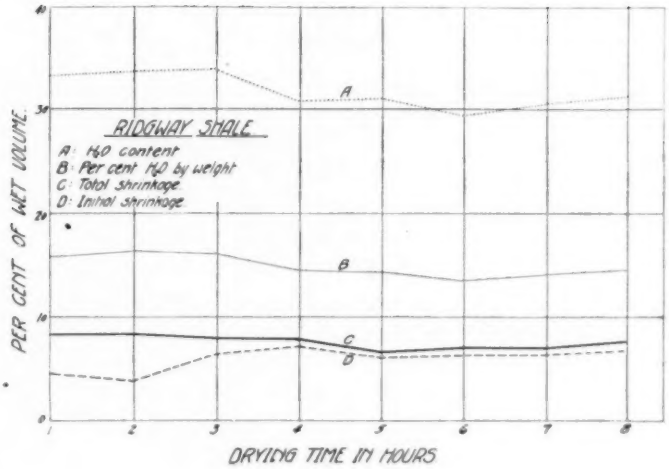

RIDGWAY SHALE
A: H2O content
B: Per cent H2O by weight
C: Total shrinkage
D: Initial shrinkage
A
B
C
D
PER CENT OF WET VOLUME
DRYING TIME IN HOURS

FIG. 3.

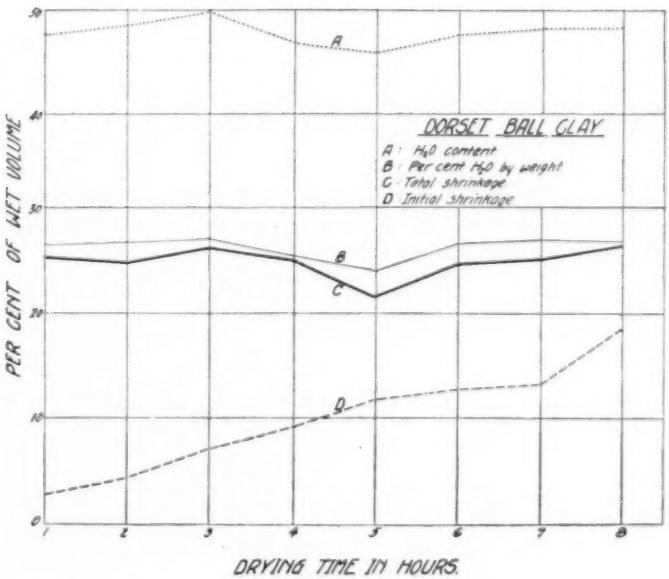

DORSET BALL CLAY
A: H2O content
B: Per cent H2O by weight
C: Total shrinkage
D Initial shrinkage
A
B
C
D
PER CENT OF WET VOLUME
DRYING TIME IN HOURS

FIG. 4.

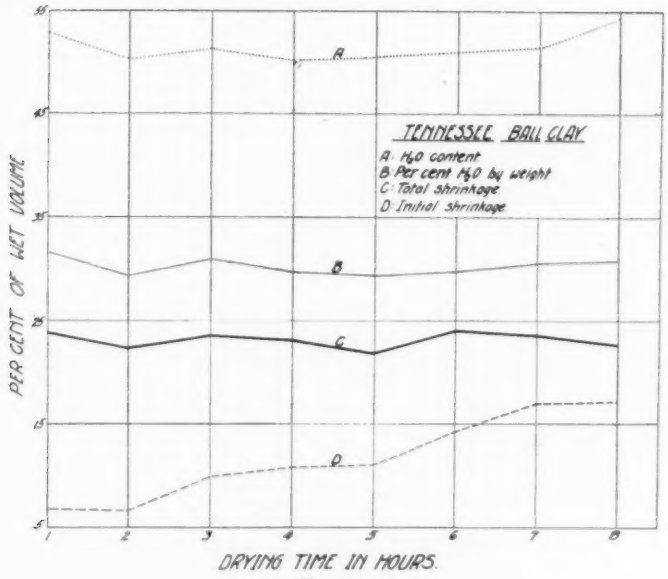

TENNESSEE BALL CLAY
A: H2O content
B: Per cent H2O by weight
C: Total shrinkage
D: Initial shrinkage
A
B
C
D
PER CENT OF WET VOLUME
DRYING TIME IN HOURS.

FIG. 5.

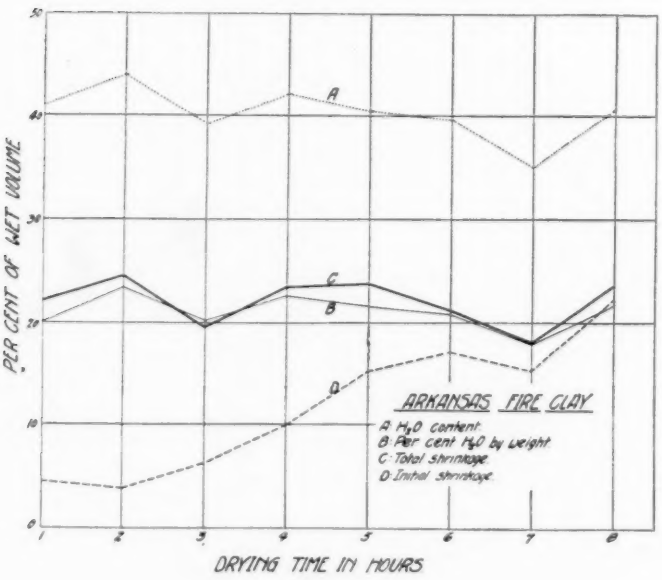

ARKANSAS FIRE CLAY
A: H2O content
B: Per cent H2O by weight
C: Total shrinkage
D: Initial shrinkage
A
B
C
D
PER CENT OF WET VOLUME
DRYING TIME IN HOURS

FIG. 6.

clay. The water content of these clays is considerably higher and even after eight hours of drying a large amount of water remains in the clay. In fact, only 33 to 38 per cent of the water has been removed. The exceedingly fine grained nature of these clays renders it impossible to remove the water at anything like the rate possible in coarser grained materials. It is not surprising therefore to find that curves C and D are far from coinciding after eight hours drying. In the case of the Dorset ball clay, it is observed that there is a decided increase in the rate of drying between the seven and eight hour treatments, a fact which can not be explained from the data at hand. A comparison of diagrams 4 and 5 tends to indicate that the American clay dries more easily, in spite of the fact that its water content is greater. The diagram of figure 6 shows the drying behavior of a siliceous fire-clay. This material is very fine grained with a water content between that of the shales and the ball clays. This fire-clay approaches the total shrinkage quite closely after the eight hour treatment. From the data thus obtained, the following conclusions may be drawn:

First, the drying time required for a given material depends largely upon the water content; second, the structure of the clay, irrespective of the water content, is an important factor which must be taken into account; third, the total shrinkage is proportional to the water content; fourth, the total shrinkage is not influenced by the rapidity of drying, that is, more rapid drying does not tend to bring about a smaller shrinkage nor does longer drying tend to yield larger shrinkage values, at least not within the drying periods employed in this work.

BUREAU OF STANDARDS
WASHINGTON, D. C.

A MERCURY VOLUMETER[1]

By Ernest F. Goodner

ABSTRACT

A new volumeter using mercury as the liquid for determining volumes of solids.

Existing volumeters.—The eight principal volumeters which have been in use during the past few years are discussed, the disadvantages and advantages being pointed out and the requisites of a satisfactory volumeter are outlined.

Description of new mercury volumeter.—The volumeter consists of a burette which may be raised or lowered by means of a rack and pinion. To the lower end of the burette there is a rubber tube attached which connects at the other end with a reservoir. This reservoir is at a fixed point, level with the bottom of the burette when raised to its highest point and is partially filled with mercury. The whole volumeter is, in action, a large "U"-tube with one movable limb (the burette). The volume is obtained by placing the briquette in the reservoir, causing a rise in the level of the mercury in both limbs of the "U"-tube. The burette is then lowered until the mercury has resumed its former level, this movement being the measure of the volume which is read directly from the graduations on the burette.

Mathematical analysis.—It is shown that a ratio of 1:1 of the reservoir and burette areas of free mercury surface will enable the reading of volumes as accurately as one can obtain the burette reading.

Comparative tests with other volumeters.—Tests of the action of mercury, water and kerosene show that they behave alike in obtaining volumes. No saturation of burned or dry briquettes is necessary when using mercury as the liquid. Volumes with pycnometer and overflow types of volumeters checked those obtained with mercury volumeter to within $^{5}/_{100}$ a cc.

Per cent variation of readings.—Results of three operators working independently indicate that for volumes above 25.00 cc. the volumeter is consistent within 0.2 per cent which is also the accuracy of the result.

Disadvantages.—1. The initial cost of about two pounds of mercury. 2. The slight tendency of the mercury to remain in cracks and holes of some briquettes, although readily shaken back into the reservoir. 3. A slight difficulty in obtaining the reading for the first dozen determinations.

Advantages.—1. No 12-hour soaking in kerosene is necessary for dry briquettes. 2. There is no draining of briquettes after immersion. 3. No

[1] Received Feb. 17, 1921. Published by permission of the Director, U. S. Bureau of Mines.

draining of liquid is necessary. 4. It is direct reading. 5. It is very speedy and accurate. 6. No adjustment is necessary before each volume is taken, and, when adjustment is required, it is very quickly accomplished. 7. There is no adjusting of ground glass stoppers.

Existing Volumeters

Throughout the country several types of volumeters, employing diverse principles, are in use for quick measurement of the volumes of ceramic products. A brief consideration of the disadvantages of each of these types will make clear the need for an improved volumeter.

Seger Volumeter.[1]—The Seger type of volumeter is the one recommended by the committee on standards of the American Ceramic Society for obtaining volumes of clay samples—plastic, dry, and fired. The only advantage which it possesses over the others is that it can handle a larger volume. The disadvantages have been summarized by Schurecht.[2] His criticisms are well-merited and apparent to anyone who has used this type of volumeter.

Pycnometer (Schurecht).—In order to overcome some of the objections, Schurecht used a true pycnometer method in which the weight of the briquette in air, the weight immersed in a liquid, and the weight of the liquid displaced, are used in determining its volume. This method involves two weighings for each volume, and a check-weighing of the pycnometer and liquid at frequent intervals.

In order to reduce the time of weighing, the balance is loaded so that the swing of the pointer represents exactly 0.1 gm. per scale division. This plan allows rapid determinations of the weights. For computing the volumes from the data thus obtained, a set of tables is used in which the values have been computed from laboratory data which depend upon the size of briquette and pycnometer used.

Shaw[3] has discussed and summed up the disadvantages of the pycnometer method in which weighing is necessary.

[1] Iowa Geological Survey, *Annual Report*, **14**, 115 (1903).

[2] Schurecht, THIS JOURNAL, **1**, 556 (1918).

[3] Shaw, THIS JOURNAL, **2**, 487 (1919).

Direct Reading Pycnometer (Shaw).—Shaw illustrates a similar apparatus in the same paper which reads volumes directly by placing the briquette in a glass bottle and filling to a mark, removing the stopper and briquette, replacing the stopper and then refilling the bottle to the mark by means of a burette delivering through a tube in the stopper. The volume of liquid run from the burette into the bottle then represents the volume previously occupied by the briquette. The advantages listed by Shaw for his apparatus are: "(1) Speed; (2) simplicity; (3) low cost; (4) sufficient accuracy."

In the manipulation of the Shaw apparatus the briquette must be wiped so that there is no free liquid on the surface, and must be allowed to drain back into the bottle after removing until no free liquid remains on the surface, for two drops of water or three of kerosene are equal to 0.1 cc., and since the volume is to be determined to tenths of a cc., this amount could readily introduce an appreciable error. Obviously, this draining will take time. Any method in which the briquette is removed from a measured volume of liquid before the volume of the briquette is determined is bound to introduce this factor of draining. Again, the stopper must be replaced exactly as it was at first to insure the same internal volume, and lastly, the burette must be allowed to drain for at least three minutes in order to obtain an accurate reading.

Hubbard and Jackson Volumeter.—This volumeter is described by Hubbard and Jackson,[1] who give detailed results of tests upon different types of apparent-specific-gravity apparatus.

Goldbeck Volumeter.—In Hubbard and Jackson's article a description is also given of an apparatus in which the liquid displaced by the briquette is allowed to overflow into a beaker and is then weighed. This is, therefore, essentially an overflow type of volumeter in which weighings must be made, and the transfer of the liquid from one vessel to another is not an accurate method for fast work.

[1] *Proc. Am. Soc. Test. Mat.*, **16**, 378–401 (1916).

Staley Apparatus.—Staley[1] has developed a volumeter which causes the rise in level of a liquid due to immersing the briquette in a reservoir, to be magnified by having the rise take place in a tube inclined slightly from the horizontal and attached to the reservoir. The above method has the following faults. The least variation in the angle of inclination of the reading tube will vitiate the results; the volumeter must be calibrated, and considerable care exercised in its manipulation; the zero point must be adjusted every time a volume is taken. Although the apparatus is very accurate, if handled properly, it is rather fragile and hard to keep set accurately.

Spurrier Volumeter.—Spurrier[2] describes a sensitive volumeter in which volumes are read directly by means of magnifying the rise in the level of a liquid by forcing the displaced volume of liquid into a capillary tube. The operation consists of filling a reservoir to a given level, placing the sample in the reservoir, and then forcing the displaced liquid into a capillary tube by means of lung pressure applied through a rubber tube attached to the top of the reservoir. This does not require any draining of the sample after placing it in the volumeter and the volume is read directly on the capillary tube.

Spurrier uses this volumeter for small volumes only; a correction must be made for capillarity and the readings must be made under practically constant temperature conditions. Also, in returning the liquid to its original level, considerable care must be exercised in order that the exact level be reached. He states that no claims are made for speed or convenience, although the instrument is exceedingly accurate and very neatly designed.

Overflow Type of Volumeter[3] (Schurecht).—In this type the bar is placed in a cylinder or reservoir having an internal tube which discharges the liquid displaced by the briquette directly into a burette, where it is measured. This type has been in use

[1] U. S. Bur. Stands. Report on Construction and Tests of a Staley Volumeter, Verbal Request of The Committee on Standards of The American Ceramic Society, Feb. 5, 1919.

[2] Spurrier, THIS JOURNAL, **3**, 400 (1920).

[3] Schurecht, THIS JOURNAL, **3**, 730 (1910).

at the U. S. Bureau of Mines stations at Columbus, Ohio, and Seattle, Wash., for some time.

The disadvantages of this method are as follows: When water is used, a hard, thin coating of dirt often forms upon the inside of the burette, causing slow drainage and the clinging of drops of water to the upper part of the tube. Any vibration of the burette to cause better draining is inadvisable because this would result in a further flow from the cylinder. The waiting, as a result, slows up the operation. The same briquette does not give the same volume, if dropped or lowered rapidly into the cylinder as is obtained if it is lowered slowly, due to little ripples flowing over the top of the tube. In rapid work the volume reading of the same briquette, when placed in different sets, varies as much as three-tenths of a cubic centimeter. The liquid, particularly water, is liable to cling to any dirt lodged upon the overflow tube, causing an error, which is particularly liable to happen with crumbly briquettes. Undoubtedly, if sufficient care and time are taken, the results may be made to check closely enough for the ordinary volumes needed in ceramic control work. These disadvantages apply in a lesser degree to the use of kerosene for measuring plastic volumes.

The advantages of this volumeter are: (1) Simplicity of construction and operation: (2) no glass stoppers are used; (3) no draining back of liquid from briquette to the volumeter is necessary; (4) if twelve to twenty-four volumeters are used, a large number of volumes may be determined rapidly.

Requisites of a satisfactory Volumeter

The requisites of a satisfactory volumeter are, briefly, the following: (1) The briquette should not be removed from the container in order to obtain its volume; (2) the volume should be obtainable by direct reading; (3) filling the container to a definite level or recharging for each determination should be avoided; (4) saturation of the briquette before immersion should be avoided; (5) the results should be consistent and accurate to 0.1 cc.

If a volumeter can meet these requirements, it will be unusually fast and accurate.

A New Mercury Volumeter

While making preliminary tests of clay samples collected in the course of a survey of the ceramic resources of the State of Washington, the writer found that the existing types of volumeters required too much time to operate. Since eighteen volume determinations for each of three hundred samples of clays burned to different temperatures were required, a volumeter was designed with the object of increased speed of operation. Mercury was adopted as the liquid for obtaining the volumes, mainly for the reason that it does not "wet" the briquettes, whether they are in the plastic, dry, or fired state. The mercury does, however, fill the holes and cracks, thereby giving correct bulk volumes. The volumeter has been tried out very carefully in actual work as well as in comparative tests and has proved satisfactory.

Principle of Operation.—The principle of the new mercury volumeter is somewhat akin to that of the apparatus used by Spurrier, although differing in the method of obtaining the zero point, and is an adaptation of the gas analysis apparatus known as a "nitrometer," which is used for determining the volume of nitric oxide liberated during the analysis of nitrates. The briquette is placed in a reservoir containing mercury, which is connected by a piece of rubber pressure-tubing to a burette[1] having an enlarged end to receive a one-hole stopper. The mercury stands ordinarily at zero. When a briquette is introduced, it causes a rise in level in both the reservoir and the burette. The burette is then lowered until the mercury has resumed its former level. This is accomplished by having the burette mounted upon a sliding frame which is actuated by means of a rack and pinion. The lowering of the burette adds more glass tubing to the circuit, which, of course, takes care of the displaced mercury. The volume is then read directly from the burette. The top of the mercury meniscus forms an excellent mirror upon which to see the reflection of the zero point.

Construction.—The construction of the volumeter is not difficult and all of the material is at hand in nearly every labora-

[1] The burette is a graduated tube from Schumann's specific gravity bottle and reads from 0 at bottom to 50 at top. Cost about $3.50.

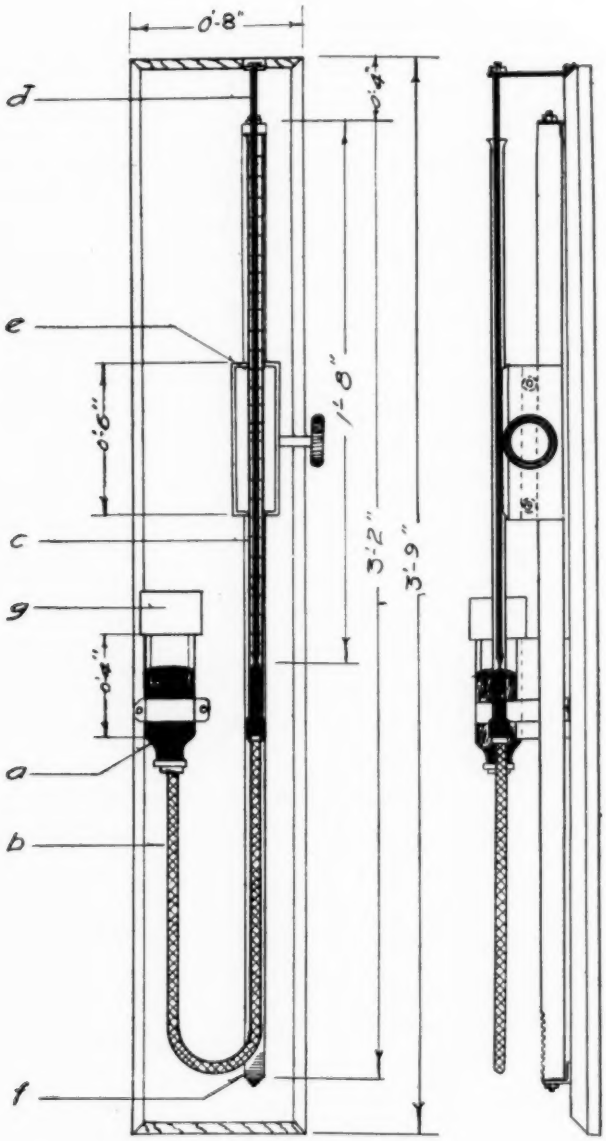


FIG. 1.

tory. The reservoir, "a" (Fig. 1), can be made from a tall, round or square bottle having a narrow neck. In this laboratory a reservoir made of glazed porcelain is being used. The diameter or width should be about $1^3/_4$ inches for standard dry test pieces. The bottom can be cut off by grinding on the edge of an emery wheel just above the seam between the bottom and sides. A rubber stopper is forced into the neck of the bottle and a 3-foot piece of rubber pressure-tubing, such as that used on suction apparatus, is attached by means of a short glass tube with a bulge at each end. The joint should be wired tightly and then waxed very securely. The other end of the tube is attached to burette "c" in a similar fashion. If a rack and pinion is to be used for raising and lowering the burette, the method shown in the drawing will be found very satisfactory.

In order to have a good, readable zero point, a pointed quarter-inch rod, "d," is bolted to the board by an iron brace and extends down inside the burette, ending at the zero point. This rod may be connected to one terminal of a bell circuit and the mercury made the other terminal, which will cause the bell to ring until the zero point is passed. However, with clean mercury, the end of the rod is reflected in the convex meniscus and the exact zero point is easily obtained.

Manipulation.—The manipulation is simple. First, after mounting solidly, the burette is raised until the lower end of the rod is exactly opposite the zero line on the burette. Then mercury is poured into the system until it touches the end of the rod, care being taken that the briquette holder is in place when the final adjustment for zero is made. The burette should then be run past this point several times in order to see that the mercury is running freely. Experience shows that on the first two or three trials one is apt to misjudge the point. However, when it has once been determined, there is no difficulty in duplicating it. The burette should always be raised in reaching the final adjustment in order to expose a clean and bright mercury surface.

The volumeter being ready for use, the briquette is placed in the holder, pushed under the mercury, and the burette then lowered until the point of the rod emerges from the mercury. The

setting is then readily obtained. The distance between the top of the mercury and the end of the rod is an indicator of the movement required for adjustment. Thus a difference of two-tenths of a cubic centimeter between the end of the rod and the top of the mercury requires about one centimeter movement of the burette. In regard to the setting of the zero point, this will have to be readjusted from time to time, either by adding a drop or two of mercury or by lowering or raising rod, "d." This is necessary after about every fifteen or twenty briquettes and may be readily checked by raising the burette to the zero point at fairly frequent intervals.

Tests of the New Volumeter

Mathematical Considerations.—The accuracy with which the volumes may be determined depends directly upon the ratio of the areas of reservoir and burette. Let us suppose that the area of the mercury surface in the reservoir is 16 sq. cm. and in the burette 1 sq. cm. Since area A times height H equals volume V, or,

$$\frac{V}{A} = H, \text{ then } \frac{V}{16 + 1} = H$$

Suppose that the volume V of the briquette is 25 cc. This volume is distributed throughout the system causing a rise of 25/17 or 1.47 cm. rise in each limb of the circuit. Hence, in a volumeter with the ratio of 16 to 1, the 25 cc. briquette would cause a rise of only 0.0587 cm. for each cc. of the briquette. With a reflection of the pointer, such as takes place in the mercury surface, it is possible to read to a much smaller length than 0.05 cm. However, let us use a volumeter with the ratio of 1 to 1. Then 25/2 or 12.5 cm. is the rise in each limb for the briquette. This is 0.5 cm. rise for each cc. of volume, or 0.05 cm. for each tenth cc. Extensive checking of the present instrument with a microscope-cathetometer showed unquestionably that the pointer may be adjusted with the naked eye to 0.003 cm. without fail. This corroborates observations by many physicists that the method of reflection reading of a point is extremely accurate.

These considerations must not be construed to mean that in reading the volume of a briquette with this mercury volumeter

one must estimate distances less than a tenth of a centimeter, for after the burette has been lowered or raised so that the mercury is at its original level, as when set at zero, *all* of the displaced volume of liquid is in the burette and the volume is read to tenths just as in the ordinary burette reading. But if in adjusting so that the reflection is just tipping the actual pointer, an error of

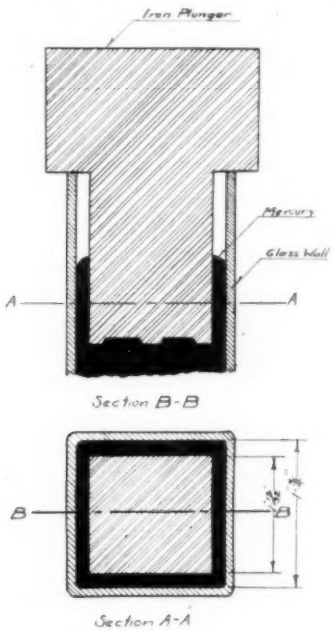


FIG. 2.

0.05 cm. is made, this will correspond to an actual error of 0.1 cc. in the briquette volume.

In order to obtain the ratio of approximately one to one for the area of the mercury reservoir to the area of the burette, it is necessary to reduce the area of free surface of mercury in the reservoir, since the cross section of the burette is necessarily fixed. This reduction is accomplished by using a heavy metal plug or plunger which has an area about one sq. cm. less than the reservoir. It is set so that it extends below the surface of the mercury when set at zero. When a bar of clay is introduced, the heavy metal plun-

ger keeps it from floating, and also confines the mercury surface to that which is free between the sides of the reservoir and the sides of the plunger (see Fig. 2). The bottom of the plunger is grooved to allow free access of the mercury above the briquette.

The question of expansion of the rubber tube, due to greater pressure caused by the increased length of mercury column when a briquette is placed in the reservoir, was answered in the following manner.

The diameter of the tube was measured by means of the cathetometer at three different points: four inches below each end, and at the lower point. A briquette of 47.0 cc. was then placed in the volumeter and the exact volume determined. The diameters were then re-measured at the same points. A maximum increase in diameter of one-fortieth of a millimeter was found at the lowest point in the tube, which may be reasonably attributed to experimental error or to increased pressure. Such an expansion throughout the total length of the tube would introduce an error of 0.005 cc. in the reading. A volume of 50.0 cc. of mercury at 13.2 gm. per cc. would weigh 660 gm. which would be distributed over the internal area of the rubber tube, or 2.03 gm./sq. cm., which is an insignificant increase in pressure for even thin tubing.

Comparative Tests.—In testing out this volumeter five burned briquettes were measured. Dry, or when saturated with water, the volumes were exactly the same. Then the saturated volumes were taken in an overflow type of volumeter using every care possible to avoid errors. The results checked within less than 0.05 cc. Plastic volumes were checked in a similar manner.

Then water was substituted for the mercury in the new volumeter, and the volumes re-determined. The same values were obtained as before. This indicates that for this purpose the action of the mercury in surrounding a briquette is the same as that of water. Finally, the volumes were measured by means of a Schurecht pycnometer and the results checked those of the mercury volumeter almost exactly.

Following this same line of reasoning, one could substitute mercury for water or kerosene in the overflow type of volumeter, and thus remove some of the draining difficulties. However, the refilling of the reservoir and setting to zero would still be necessary.

Laboratory Tests.—As an independent check, two graduate fellows from the Department of Chemistry in the University of Washington were asked to use this volumeter in determining the volumes of 200, 100, 50, 20, and 10-gram weights. The volumes were unknown to the operators and independent determinations were run. The actual volumes were determined by taking the weights in air and immersed in water, correcting for the volume of the wire support, and thus determinig their true volumes. This was done after the volumeter readings had been taken. The results follow.

Weight	200.00	100.00	50.00	20.00	10.00	Observer,
Reading	25.10	12.95	6.60	2.45	1.45	1
	25.10	12.95	6.50	2.45	1.45	1
	25.10	13.00	6.50	2.45	1.45	1
	25.15	13.00	6.55	2.45	1.45	2
	25.10	13.00	6.55	2.50	1.48	2
	25.10	13.00	6.50	2.45	1.45	3
	25.10	12.95	...	...	...	3
	25.10	13.00	...	...	...	3
	25.15	13.00	...	...	...	3
Mean	25.11	12.98	6.53	2.46	1.455	
Per cent variation	0.1592	0.2311	1.07	1.625	0.344	
Exact vol	25.150	13.001	6.53	2.475	1.40	
Per cent error	0.1590	0.1540	0.00	0.601	3.930	

The above results indicate that the volumeter is very consistent, for the variations were less than two-tenths of one per cent, even with different operators, while measuring volumes comparable with those of test clay briquettes, and finally, that for the volumes greater than 10 cc. the error of the mercury volumeter is less than two-tenths of one per cent based upon the true volumes as determined by loss in weight when immersed in water.

Summary

Disadvantages.—The disadvantages may be summed up as follows: (1) the initial cost of about two pounds of mercury; (2) slight tendency of mercury to remain in small holes and cracks of some briquettes, although it is readily shaken back into the

reservoir, and (3) a slight difficulty in obtaining readings for the first dozen determinations.

The precautions to be taken are these: Make absolutely rigid and tight connections with rubber pressure-tubing; use clean mercury, and check zero point after every few volume readings.

To clean mercury, it is only necessary to press it through the mesh of a clean handkerchief. Dust and dirt will float to the top of the mercury in the reservoir and can be easily blown off by means of a rubber tube and the breath. Occasionally the burette should be wiped clean by means of a burette brush, removal of the mercury during this operation not being necessary.

Advantages.—The advantages of this volumeter are as follows: (1) No twelve-hour soaking in kerosene is necessary for dry briquettes; (2) no draining of briquettes after immersion; (3) no draining of liquid; (4) it is direct reading; (5) it is very speedy and accurate; (6) no adjustment is necessary for every volume taken and when adjustment is required it is very quickly accomplished; (7) there is no adjusting of ground glass stoppers.

The writer wishes to acknowledge his indebtedness to Professor Hewitt Wilson, head of the Ceramics Department of the University of Washington and ceramist of the U. S. Bureau of Mines, for his interest and many helpful suggestions during the development of the volumeter, and also to Dr. H. V. Tartar, who kindly placed the physical chemistry laboratory of the University of Washington at the disposal of the writer for testing the volumeter.

College of Mines, University of Washington
Seattle, and Northwest Experiment Station
U. S. Bureau of Mines

THE RELATION BETWEEN THE FINENESS AND OTHER PROPERTIES OF CALCINED GYPSUM[1]

By W. E. Emley and F. C. Welch

ABSTRACT

Experimental methods.—The *normal consistency* was measured by the Southard viscosimeter, the *time of set* by the Vicat needle, and the plasticity by spreading upon a porous porcelain plate.

Conclusions.—(1) Normal consistency is obtained with less water the coarser the calcined gypsum, (2) the finer the material the shorter the time of set, (3) the finer the calcined gypsum the stronger is the set material until the degree of fineness beyond that of size 6 (A. S. T. M. spec.) after which increase in fineness is accompanied by decrease in strength, (4) the finer the calcined gypsum the more sand it will carry.

When attempting to prepare specifications for calcined gypsum, it was believed advisable to classify the material according to its fineness. Of course, fineness, *per se*, is of no great importance to the user. There are physical properties which are of importance to the user and for which no method of measurement has been definitely adopted. Experience seemed to indicate that these properties are more or less closely related to the fineness and that a measurement of the fineness would give some kind of an indication of the plasticity, sand carrying capacity, and similar properties. Unfortunately, no exact information was available as a basis for these relationships, and recourse was had to commercial conditions. Screening analyses were made of many samples of calcined gypsum, and the classification as to fineness was based upon these results.

This classification[2] states that calcined gypsum, "size No. 4," shall all pass an 8-mesh sieve (No. 8),[3] and not less than 40 nor more than 60 per cent of it shall pass a 100-mesh sieve (No. 100).

[1] Received Feb. 12, 1921. Published by permission of the Director, U. S. Bureau of Standards.

[2] A. S. T. M. Tentative Specification for Calcined Gypsum, C23–19T.

[3] Figures in parentheses refer to equivalent sieves of the U. S. Standard Sieve Series.

Size No. 5 shall all pass a 14-mesh sieve (No. 16), and not less than 60 nor more than 80 per cent of it shall pass a 100-mesh sieve (No. 100). Size No. 6 is such that all of it will pass a 28-mesh sieve (No. 30), and not less than 80 per cent of it will pass a 100-mesh sieve (No. 100).

Comparatively little calcined gypsum is used as such. Most of it goes into the manufacture of gypsum wall plasters and other gypsum products. It is desirable to know whether or not one or more of the sizes defined above is best adapted for a given purpose. Accordingly, a sample of calcined gypsum was screened to produce material of the three sizes listed, and each size was tested for normal consistency, time of set, tensile strength, combined water, plasticity, and sand carrying capacity. A fourth size was added, which we may call "No. 7," and define as such that all of the material will pass a 100-mesh sieve (No. 100). The first lot of calcined gypsum was unretarded; the entire series was repeated using retarded material.

Methods

Normal consistency is defined to mean the quantity of water (in cubic centimeters) which must be added to 100 grams of the calcined gypsum to produce a mixture which will have a consistency of 9.7 centimeters, when measured by the Southard viscosimeter.[1]

The time of set is the elapsed interval between the time when the sample is added to the water, and the time when a Vicat needle will no longer penetrate to the bottom of the pat. The ratio of water to sample is such as to produce a mixture of normal consistency.[2]

The tensile strength was measured by breaking three briquettes of the usual form. The briquettes were made of paste of normal consistency, and were stored in the air in the room until seven days old.

[1] A. S. T. M. tentative Methods for Tests of Typsum and Gypsum Products, C26–19T. See also Emley and Faxon, THIS JOURNAL, **4**, 152 (1921).

[2] Emley, "Measurement of Time of Set of Calcined Gypsum," *Trans. Amer. Ceramic Soc.*, **1917**, 573.

	Unretarded				Retarded			
Size No.	4	5	6	7	4	5	6	7
Per cent by weight passing 100 mesh sieve	40	60	80	100	40	60	80	100
Normal consistency (cc. water)	56.9	53.7	55.9	61.2	50.9	53.3	58	61.4
Time of set	$10^1/_2$ m.	10m.	$10^3/_4$ m.	$8^1/_4$ m.	4h. 16m.	4h. 18 m.	3h. 5m.	2h. 46m.
Tensile strength (lbs. per sq. in.)	234	327	353	276	196	176	199	145
Combined water (per cent)	5.11	5.59	5.49	5.46	8.71	8.60	8.01	9.02
Plasticity figure	122	99	113	98	107	114	94	89
Sand carry capacity (parts by wt.)	1:3.2	1:3.8	1:2.5	1:4.3	1:1.3	1:1.7	1:2.6	1:3

By combined water, is meant that held by the gypsum or calcined gypsum as water of crystallization.[1]

The plasticity is measured by spreading a paste of normal consistency upon a porcelain plate of known absorptive capacity, at a constant rate.[2]

When increasing proportions of the calcined gypsum in a paste of normal consistency are replaced by equal weights of sand, the plasticity figure of the mixture decreases, approaching that for sand. When the figure has decreased to a certain predetermined minimum, the ratio of calcined gypsum to sand is taken to be the sand carrying capacity of the calcined gypsum. Using the commercial plastering sand of Washington, measurements were made for each ten per cent variation in composition from 100 per cent calcined gypsum to 100 per cent sand, and the figures given were determined by interpolation.

Results

The experimental results are shown in the table on preceeding page.

Conclusions

It is dangerous to attempt to draw conclusions from such a small amount of data; it is safer to call the following "indications" rather than conclusions.

The finer the calcined gypsum, the more water will be required to make a paste of normal consistency. This statement is logical, and is borne out by the results obtained from the retarded material. The discrepancies shown by the unretarded sample are not explained. Size 7 of this sample follows the above rule.

The finer the calcined gypsum, the more quickly it will set. This statement is also logical, and is borne out by both sets of data. Within the limits of the specifications, however, the fineness does not have much influence on the time of set.

The tensile strength of the unretarded material brings out an

[1] For the method of determination, see A. S. T. M. specification C26–19T. It consists of noting the loss of weight when the material is dried for two hours at 45°C.

[2] Emley, *Measurement of Plasticity of Plasters and Mortars*, Bureau of Standards Tech. Paper No. **169**.

unexpected fact: It seems logical to suppose that the finer the calcined gypsum, the more completely will it react with water, and therefore the stronger the set material should be. On the other hand, it is known that the finer material will require more water, and that this extra water may be regarded as a source of weakness. The results indicate that, within the specifications, the former factor is predominant; that increased fineness of the calcined gypsum is accompanied by increased strength of the set material. When, however, the calcined gypsum is finer than that recognized by the specifications, the amount of mixing water becomes the predominant factor. Any increase in fineness beyond that defined as class 6 is apparently accompanied by a decrease of strength.

It has frequently been stated that a given material is most plastic when it is neither too fine nor too coarse, but is composed of fine and coarse particles in their proper proportions. The plasticity figures given for the retarded material seem to indicate that there is some foundation for this statement. The discrepancies shown by the unretarded sample, both in plasticity and sand carrying capacity, can probably be explained by the fact that the setting reaction had attained a measureable velocity before the plasticity determination was complete.

The finer the calcined gypsum, the more sand it will carry. The truth of this statement is generally accepted, and is plainly indicated by the tests of the retarded material. If it is true, as is indicated above that the condition for maximum plasticity is a definite relation between the amounts of coarse and fine material, it seems obvious that when a material is too fine for maximum plasticity, the addition of a certain amount of sand will tend to improve the plasticity by restoring the proper balance between fine and coarse particles. The finer the material, the more sand will be required for this purpose.

CERAMIC ABSTRACTS

Author Index[1] to Abstracts for April

Author	Number of Abstract
Anon.	5, 28, 29, 36, 51, 52
Bechhold, H.	22
Bied, J.	60
Bogue, R. H.	25
Booth, W. H.	43
Boveroulle, R.	62
Brooke, Frank W. and Mides, George P.	38
Candlat, C. E.	61
Carborundum Co. patent	49
Circular, Bureau of Standards	59
Dolt, M. J.	16
Dushman, S.	17
Evens, Edmund M.	21
Essich, O.	40
Fischer, Ferd	44
Fritsch, J.	63
Gondriaan, F.	23
Gibson, Walcot	45
Griffin, R. C.	27
Gross, N.	56
Hacker, W.	7
Hadding, A.	18
Herington, C. F.	46
Hodson, Frank	35
Jackson, S'r Herbert	53
Kalender, Tonindustrie	15
Keeney, Robert M.	37
Lassally, A.	8
Le Chatelier, Henry	47
Lockhart, L. B.	9
Logan, W. N.	34
McBride, R. S.	4
Mansfield, George R.	31
Marr, Otto	19
Metz, Carl and Hager, Hermann	20
Mitchell, Edmund I.	3
Morel, J.	42
Pascal, Raoul	10
Pfaff, U. and Donath, M.	1
Pfannenschmidt, P. L.	55
Phillips, F. J. and Rose, E. J.	54
Powell, A. L. and Summers, J. A.	57
Ramdohr, Paul	30
Rept. of Lubricants and Lubrication Com.	11
Rept. Fuel Research Board	48
Schmidt, O.	12
Schreinemakers, F. A. H. and Miss W. C. de Baat	24
Schuss Gebr.	58
Smith W.	6
Smyth, F. H. and Roberts, H. S.	26
Staley, Homer F.	41
Still, Alfred	50
Stone, Ralph W.	33
Strane, A. J.	2
Spurr, J. E.	32
Terres, E.	39
Thompson, W. P.	13
Thomsen, T. C.	14

[1] The abbreviation (C. A.) at the end of an abstract indicates that the abstract was secured from the Editor of *Chemical Abstracts* by coöperative agreement.

General and Miscellaneous

1. Graphical methods of computing the composition of ceramic bodies. U. PFAFF AND M. DONATH, Porcelain Factory, Freiberg in Saar. *Ber. d. Deut. Keram. Gesell.*, **1**, Pt. 2, 21–32 (1920).—Figure 1 represents the rational

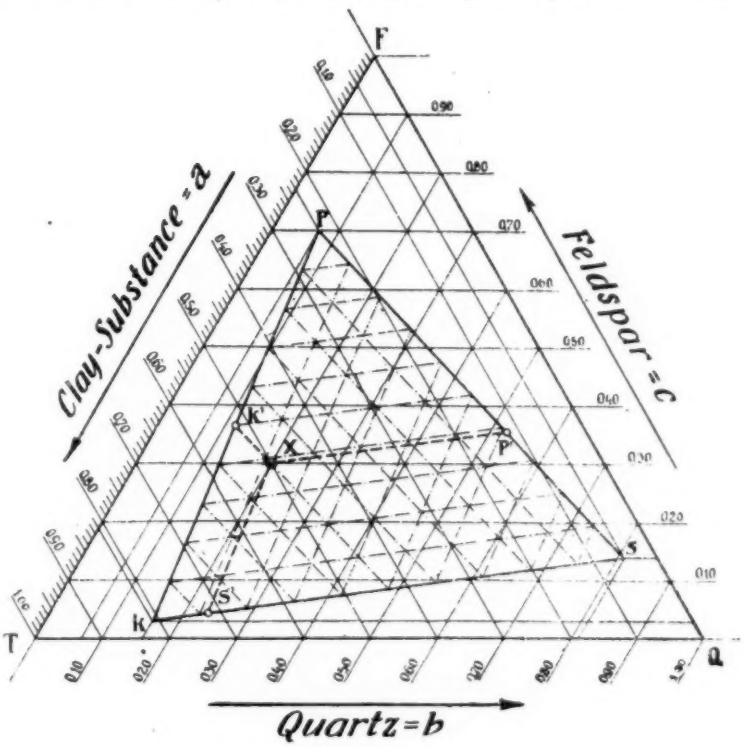


FIG. 1

composition of a clay, a sand, and a feldspar in terms of kaolin, quartz, and feldspar. The clay has the composition shown by point K, the sand by S, and the feldspar by P. It is desired to find in what proportions to mix the clay, sand, and feldspar to give a body having the composition represented by the point X. From the point X, lines are drawn, XK′, XP′, XS′, parallel to the sides of the triangle KSP. The fraction K′P/KP = fraction of clay. S′K/SK = fraction of sand, and P′S/PS the fraction of feldspar to be used to give the body represented by point X. Only bodies represented by points within the triangle KSP can be prepared from the three materials, K, S, and P. The body X could also be obtained from a mixt. of S. and P with another material K, by a similar procedure. Let $a + b + c = 1$ be the fractions of

K, S, and P required, and $a_1 + b' + c' = 1'$ be the fractions of K_1, S and P required to give X, then a mixt. of m parts of 1 with $(1 - m)$ parts of 1′, giving a mixt. also with the composition X will contain $(m \times a)$ parts of material K,

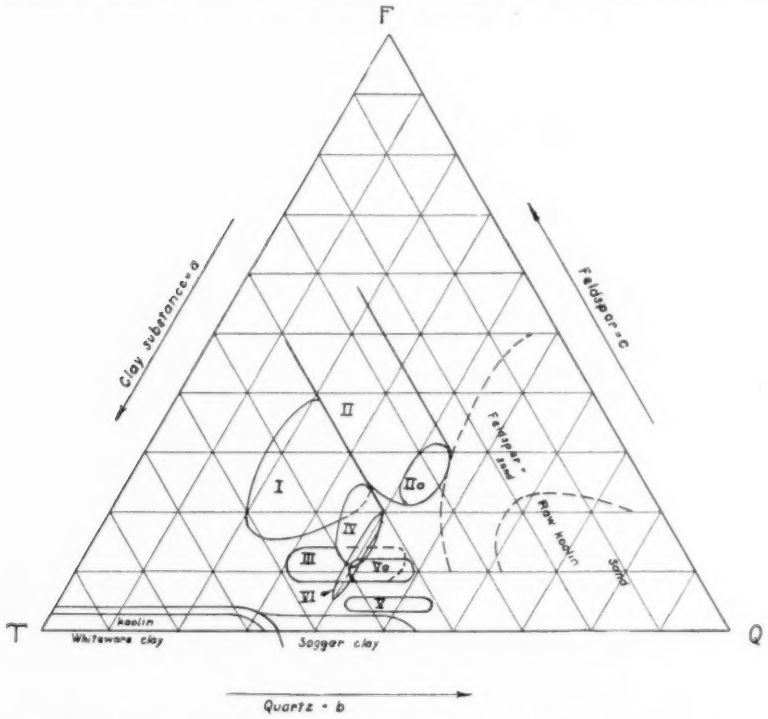


FIG. 2.—I, Hard porcelain; II, soft porcelain; IIa Japanese porcelain; III, semi-porcelain; IV stoneware; V, whiteware; Va, new German vitreous whiteware; VI, calcareous whiteware.

$[(1 - m).a_1]$ parts of K_1, $[m(b - b') + b']$ parts S, and $[m(C - C') + C']$ parts P. A rational composition diagram of several porcelain and stoneware bodies is given in figure 2. E. N. BUNTING

2. Modern commercial explosives and their uses. A. J. STRANE. *Trans. Am. Inst. Mining Met. Eng.*, **1920**, 7 pp. (advance copy).—S. describes nitroglycerin, blasting gelatin, straight nitroglycerin dynamites, straight gelatin dynamite, extra, or ammonia, dynamites and gelatin, low-freezing nitroglycerin explosives, permissible explosives, non-freezing explosives and black blasting powder, giving in general the compn., properties and form of commercial packages. CHARLES E. MUNROE (C. A.)

3. Schedule of fees for consulting engineers. EDMUND I. MITCHELL. *Mining & Metallurgy*, **169**, 15–17 (1921).—A summary and bibliography of the information on this topic which has been published in technical journals during the past ten years. C. W. PARMELEE

4. The engineering profession and government technology. R. S. McBRIDE. *Chem. Met. Eng.*, **23**, 1265–7 (1920). E. J. C. (*C. A.*)

5. Lubricants and lubrication. ANON. *Chem. Trade J.*, **67**, 769–70 (1920). —The report of the Lubricants and Lubrication Inquiry Committee issued by the Advisory Council of the Department of Scientific and Industrial Research is reviewed and a list of 13 recommendations for future research is given. EUGENE C. BINGHAM (C. A.)

PATENTS

6. Treating clays. W. SMITH. Brit. 149,440, May 13, 1919. In the production of articles and materials from clay, the clay is heated together with a material containing volatile C compds., such as bituminous or oil shale, with the exclusion of air, the excess C being left within the mass of the article. The clay may be impregnated with volatile C compds., or the biscuited articles may be charged with gaseous or liquid carbonaceous compds. and heated with the exclusion of air. The firing may be effected by embedding the clay article in powdered coke or oil shale, and the temp. used may be sufficient to seal up the C in the clay. The carbonized clay may be treated with clay slips, glazes, or enamels. *Abrasives* may be formed by satg. clay with C as above, heating to a very high temp., say 1600°, and grinding the material (C. A.)

BOOKS

7. HACKER, W.: **Handbuch der Kitte und Klebemittel.** Meissen: Math. Bohlmann. 161 pp. M. 15. (C. A.)

8. LASSALLY, A.: **Bild und Film im Dienste der Technik. Part I. Betriebsphotographie.** 118 pp. M. 5.30, bound M. 6.30. **Part 2. Betriebskinematographie.** 247 pp. M. 12.60, bound M. 13.85. For review see *Z. ver. deut. Ing.*, **64**, 1094 (1920). (C. A.)

9. LOCKHART, L. B.: **American lubricants.** 2nd Ed. revized and enlarged. Easton, Pa.: The Chemical Publishing Co. 341 pp. $4.00. For review see *Am. J. Sci.*, **1**, 89 (1921). (C. A.)

10. PASCAL, RAOUL: **Synthèses et catalyses industrielles.** Lille: G. Janny, 4, place Philippe-Lebon. 238 pp. For review see *Ind. chim.*, **7**, 376 (1920). (C. A.)

11. Rept. of the Lubricants and Lubrication Inquiry Comm. Advisory Council Dept. of Scientific and Industrial Research. London: H. M. Stationery Office. 2s. 6d. (C. A.)

12. SCHMIDT, O: **Chemie für Technicker. Leitfaden für Maschinen- und Bautechniker.** 8th Ed. revized. Stuttgart: Konrad Wittwer. M. 7. (C. A.)

13. THOMPSON, W. P.: **Handbook of Patent Laws of All Countries.** 18th Ed. revized. London: Stevens & Sons, Ltd. 157 pp. 6s. For review see *Nature*, **106**, 275 (1920). (C. A.)

14. THOMSEN, T. C.: **The Practice of Lubrication.** New York and London: McGraw-Hill Book Co. 607 pp. $6.00. For review see *Proc. Am. Soc. Civil Eng.*, **46**, 879 (1920). (C. A.)

15. **Tonindustrie-Kalender 1921** (in 2 parts). Berlin: Verlag der Tonind. Ztg. G. m. b. H. M. 8.50 for both parts. For review see *Tonind.-Ztg.*, **44**, 1287 (1920). (C. A.)

16. DOLT, M. L.: **Chemical French.** Second Ed. Easton: The Chemical Publishing Co. 413 pp. $4. For review see *J. Phys. Chem.*, **24**, 754 (1920). (C. A.)

Apparatus and Instruments

17. **Methods for the production and measurement of high vacua.** S. DUSHMAN. *Gen. Elec. Rev.*, **24**, 58–68 (1921).—Discussion of the absorption of gases by charcoal and Pd black. C. G. F. (C. A.)

18. **Apparatus for grinding rock specimens.** A. HADDING. *Geol. För. Förh.*, **42**, 378–83 (1920).—An app. tested at Lunds Geologisk-Mineralogiska institution filled these requirements satisfactorily: several specimens of varying thickness could be prepd. at the same time, each specimen finished could be easily removed and another put in its place without stopping the grinding of the other specimens, the grinding of each specimen was automatically stopped when the specimen reached a predetd. thickness, the app. could be left running without attention, and it was moderately simple and inexpensive. Two cuts and 1 diagram explain its construction clearly. The rock specimens are fastened with wax to the bottoms of 8 rock holders (Fe disks with shafts) held in the periphery of a circular metal plate properly supported above a rotating cast-iron plate onto which water and carborundum powder are fed. Springs hold the specimens, both thick and thin, against the plate with equal pressure. A special device prevents individual specimens from being completely ground away although the app. is still running. The rotating plate may be driven by an electric motor or by hand or foot power. It is recommended that the app. be used for rough grinding and that the final fine grinding be done by hand. WILHELM SEGERBLOM (C. A.)

BOOKS

19. MARR, OTTO: **Das Trocknen und die Trockner.** 3rd Ed. enlarged by Karl Reyscher. Berlin: R. Oldenbourg. 544 pp. M. 60, bound M. 65. (C. A.)

20. METZ, CARL AND HAGER, HERMANN: **Das Mikroskop und seine Anwendung. Handbuch der praktischen Mikroskopie und Anleitung zu mikroskopischen Untersuchung.** 12th Ed. revized. Berlin: Julius Springer. M. 38. For review see *Chem.-Ztg.*, **44,** 855 (1920). (C. A.)

21. EVENS, EDMUND M.: **Pumping by Compressed Air.** New York: John Wiley & Sons, Inc. 266 pp. $4.00. For review see *Proc. Am. Soc. Civil Eng.*, **47,** 948 (1920). (C. A.)

Chemistry, Physics and Geology

22. **A capillary phenomenon.** H. BECHHOLD. *Kolloid.-Z.*, **27,** 229–33 (1920).—On attempting to impregnate porous cells (unglazed porcelain, burned kieselguhr) with an insol. ppt. produced, *i. e.*, by the interaction of $AgNO_3$ with KCNS or of $CuSO_4$ with NaOH, it was found that the reaction product was concd. mainly in the exterior layer of the cell wall, although one salt was uniformly distributed initially by soaking the cell in its soln. The phenomenon seems to be a general one. Ordinary garden earth when wet with solns. of NaCl, $BaCl_2$, and $Al_2(SO_4)_3$ and then allowed to dry slowly, showed enormous concn. of the salts in the upper layers. The importance of the phenomenon in relation to *efflorescence on brick-work* was discussed. The theory is being investigated, the most probable explanation being the growth of larger crystals at the expense of smaller ones. J. A. (C. A.)

23. **Aluminates of sodium. Equilibria in the system Na_2O–Al_2O_3–H_2O** F. GOUDRIAAN. *Proc. Acad. Sci. Amsterdam*, **23,** 129–42 (1920). (C. A.)

24. **The arsenites of lithium and potassium.** F. A. H. SCHREINEMAKERS AND MISS W. C. DE BAAT. Univ. Leyden. *Rec. trav. chim.*, **39,** 423–8 (1920). (C. A.)

25. **Hydrolysis of the silicates of sodium.** R. H. BOGUE. *J. Am. Chem. Soc.*, **42,** 2575–82 (1920).—H-ion concns. were measured at 30° of solns. 1/3, 0.1, 0.05, 0.02 and 0.01 molar of 7 silicates in which SiO_2/Na_2O varied from 4/1 to 1/1. The data indicate either that these silicates are much less hydrolyzed in dil. soln. (1.58–28.43% in 0.01 molar soln.) than has been supposed or else that the electrometric method is unsuitable for measuring such dissocn., possibly because colloidal SiO_2 is able to adsorb or retard OH ion. The data confirm Na_2SiO_3 to be most hydrolyzed and the degree of hydrolysis to decrease as more SiO_2 is added to the mol. A. R. MIDDLETON (C. A.)

26. **The system cupric oxide, cuprous oxide, oxygen.** F. H. SMYTH AND H. S. ROBERTS. *J. Am. Chem. Soc.*, **42,** 2582–2607 (1920).—Solid soln. of of Cu_2O in CuO does not take place in the temp. range where both oxides remain solid. The pressure temp. equil. curves have been established over the range in which the oxides remain solid, below the eutectic pt., and above the eutectic pt. where CuO remains the solid phase, up to 1233°. The quadruple point lies at 1080.2° and 390 mm. Pure CuO does not melt without

dissocn. below 1233°. The general direction of the equil. curve is indicated for the system when Cu_2O remains the only solid phase and the theoretical deduction is confirmed that the equil. pressure drops with rise of temp.

A. R. MIDDLETON (C. A.)

27. The solubility of metals in acids containing formaldehyde. R. C. GRIFFIN. *J. Ind. Eng. Chem.*, **12**, 1159–60 (1920).—Exptl. results are tabulated which show the inhibitory effect upon the soln. of metals by mineral acids caused by the presence of HCHO. This effect is marked in the case of ferrous metals. A practical application in the use of HCl containing 1% HCHO, which secures pickling of rusty steel without appreciable effect upon the steel itself.

W. H. BOYNTON

28. Graphite deposits in Siberia. ANON. *J. Roy. Soc. Arts*, **68**, 442 (1920).—Extensive deposits of graphite exist on the left bank of the River Kureika, near its junction with the Yenisei. The graphite area forms a horizontal plateau, the elevation of which varies from 20 to 50 feet above the normal level of the Kureika. The plateau contains two layers of graphite, of a solid steel-grey color, soft, and of an excellent quality for the manufacture of pencils. Analysis: 89.51% C, 0.60% H, and 9.89% residue. The graphite is not inflammable and is very plastic. The color constituent is said to be of superior quality.

J. L. CRAWFORD

29. Chrome ore deposits in Asia Minor. ANON. *J. Roy. Soc. Arts*, **68**, 564–67 (1919).—The chrome producing districts of Turkish Asia Minor are classified in four zones: Brusia, Smyrna, Adana, and Konia. Brusia Province produces 10,000 to 15,000 tons of high grade (44–55% Cr_2O_3) ore annually, Smyrna 7,000 to 15,000 tons (40–55% ore), Adana 1,000 tons (50–51% Cr_2O_3) and Konia 1,000 tons. Transportation and mining methods are primitive.

J. L. CRAWFORD

30. The basalts of the "Blaue Kuppe bei Eschwege" and adjacent occurrences, and their cristobalite. PAUL RAMDOHR. *Centr. Min Geol.*, **1920**, 33–6.—R. describes the cristobalite in detail. Crystals are generally smaller than 1 mm. and milky white. They occur in 3 habits: (1) Well shaped octahedra; (2) 6-sided plates; and (3) crystals that are geometrically identical with tridymite. All become isotropic at 235–250°C.; d. = 2.290–2.320, n = 1.485; birefringence = 0.0018. There are all transitions between habit 1 and 2, the latter being the commoner. The transitions, as well as twinning according to the spinel law, indicate that habit 2 represents distorted octahedra. There are also transitions between habits 2 and 3 and closer investigation of the apparent hexagonal prisms reveal that they are built up by a oscillatory combination of the octahedron and cube. Interpenetration twins of the tridymite type after (1016) and (3034) also occur and are shown to be due to distortion of different octahedral faces of two octahedrons in parallel position.

OTTO VON SCHLICHTEN (C. A.)

31. **Potash in New Jersey Greensands.** GEORGE R. MANSFIELD. *Mining & Metallurgy*, **169**, 28–29 (1921).—An abstract. The U. S. Geol. Survey and the N. J. Dept. of Conservation and Development in a joint investigation of borings and well drillings for five selected areas in the southern half of the State, estimate the average content of potash in the greensand, its tonnage and its value. Mention is made of the four companies engaged in producing potash and the nature of their products, also of the utilization of greensand in the manufacture of *cement* and the recovery of the potash from the flue dust.
C. W. PARMELEE

BOOKS

32. SPURR, J. E.: **Political and Commercial Geology and the World's Mineral Resources.** N. Y.: McGraw-Hill Book Co., Inc. 561 pp. $5.00. (C. A.)

33. **Gypsum in 1919.** RALPH W. STONE. U. S. Geol. Survey. *Mineral Resources of U. S.*, 1919, Pt. II, 99–113 (Preprint No. 8, publ. Dec. 28, 1920).
E. J. C. (C. A.)

34. LOGAN, W. N.: **Kaolin of Indiana.** Indianapolis: The Dept. of Conservation, State of Indiana, Division of Geology. 132 pp. For review see *Chem. Met. Eng.*, **23**, 1138 (1920). (C. A.)

Refractories and Furnaces

35. **Heat losses through electrodes in electric furnaces.** FRANK HODSON. *Iron Age*, **106**, 1262–3 (1920). C. G. F. (C. A.)

36. **Electric furnace usage fast increasing.** ANON. *Elec World*, **77**, 77–9 (1921).—A short review of the electrochem. and electrothermal industries during 1920. C. G. F.(C. A.)

37. **The present status of the electric furnace in the American metal industries.** ROBERT M. KEENEY. *Chem. Met. Eng.*, **23**, 980–4 (1920). (C. A.)

38. **Electric versus combustion furnaces for low temperatures.** FRANK W. BROOKE AND GEO. P. MILLS. *Chem. Met. Eng.*, **23**, 1008-10 (1920).—The more recent com. applications of elec. energy to low temp. work (up to 1000°) are discussed. The advantages of elec. heat over that from combustion are summarized as: (1) Absolute control of temp; (2) saving in labor (no handling of coal, ashes, oil, etc.); (3) upkeep cost inconsiderable; (4) smaller space required; (5) reduction of rejections in finished product; (6) improved product; (7) ideal shop conditions. The items of temp. control, first cost, maintenance, and cost of operation are considered separately and it is shown that, all things considered, the elec. furnace is frequently the most economical installation.
W. E. RUDER (C. A.)

39. **Comparative heat efficiency of generator-gas firing and pulverized-coal firing.** E. TERRES. *J. Gasbel.*, **63**, 673–5 (1920).—The comparative

thermal efficiencies of gas firing and pulverized-lignite firing are 53.29% and 75.73%, the difference being the heat required to convert the lignite into gas.
J. L. WILEY (C. A.)

40. The addition of carbonic acid gas to the generator process. O. ESSICH. *Feuerungstechnik*, **8**, 184–5 (1920).—Attempts at solving the problem of improving the generator process in past years resulted mostly in failures (of records of these attempts see Fischer's Year Book 1890, p. 190 and 1893, p. 233).—The increasing price of fuel demands the solution of the problem. There is no doubt that there is a certain amt. of advantage in the addition of furnace gases containing CO_2 to the vaporization atm. E. discusses advantages and disadvantages of the process and offers suggestions for suitable expts. The following advantages are anticipated: (1) Greater evolution of gas per kg. of fuel; (2) reduction of steam demand; (3) consequent reduction of steam production; (4) better adaptation of the gases for metallurgical purposes (Martin furnace); (5) production of warm waste gases by the addition of hotter waste gases. At generator temp. of 500–1000° there is an addition of 1 cc. CO_2 gas to 5 cc. O, both entering at same temp. The waste gases are hot and theoretically the CO_2 content of the mixt. can be increased up to 0.5% for each 100° temp. of waste gases. A disadvantage is the danger that through lowering of temp. in the generator chem. equil. will be shifted and a higher CO_2 content will appear in the gas. Only a moderate CO_2 increase, however, is anticipated. It is pointed out that the CO_2 addition must be const. The addition of waste gases is not permissible in the reduction zone but must be made in the upper half of the combustion chamber.
H. C. PARISH (C. A.)

41. Possibilities for research and development in the field of refractories. HOMER F. STALEY. *Chem. Met. Eng.*, **23**, 1167–71 (1920).—The annual production of refractories in the United States is about $72,000,000. Fire-brick have an annual value of $36,000,000; silica brick of $20,000,000; magnesite refractories of $6,500,000. Under existing conditions research of great monetary value must lie in the field of these three. Economic considerations rather than lack of technical skill and knowledge limit the field of research and prevent the development of new refractories. Among commercially feasible possibilities are the more extended use of sillimanite refractories, of the diaspore clays and of magnesium spinel. For special purposes the use of carborundum, fused alumina and zirconia refractories should be developed. As a rule refractory coatings on less refractory foundations are not satisfactory. An extension of the use of heat insulating materials may result in a radical change in the use of refractories. The development of an insulating material that will not shrink at maximum furnace temperatures would bring about drastic changes in the design of electric furnaces. A. J. LAMBERT

PATENTS

42. Alumina. J. MOREL. Brit. 149,769, May 17, 1919. Al_2O_3 is obtained from bauxite or other aluminous material by furnacing the latter in the pres-

ence of SO_2, air and steam, lixiviating the product, and then decomposing the resulting ferruginous soln. of $Al_2(SO_4)_3$ by means of $Na_2S_2O_3$ according to the equation $Al_2(SO_4)_3 + 3Na_2S_2O_3 = Al_2O_3 + 3SO_2 + 3S + 3Na_2SO_4$. The ppt. of Al_2O_3 and S is calcined to produce pure Al_2O_3 and SO_2. In order to make the process cyclic, the SO_2 from this source, as well as that evolved according to the equation, may be utilized both for the furnacing operation and for the regeneration of the $Na_2S_2O_3$. The latter is prepd. by evapg. to dryness the soln. of Na_2SO_4 which remains after filtering off the Al_2O_3 and S, reducing the sulfate to sulfide by means of C, and then passing air and SO_2 into the aq. soln. of Na_2S. If the process is not intended to be cyclic, the S is sepd. from the pptd. Al_2O_3 by distn. or dissolution. To facilitate the furnacing operation, the gases may be passed over a catalyst such as Fe_2O_3; or a catalyst, such as Al or other chloride, may be added to the bauxite. (C. A.)

BOOKS

43. BOOTH, W. H.: **Fuel Economy.** 2nd Ed. revized. London: S. Rentel. & Co., Ltd. 92 pp. 2s. 6d. net. For review see *Tech. Review*, **6**, 777 (1920). (C. A.)

44. FISCHER, FERD: **Taschenbuch für Feuerungstechniker.** 8th Ed. newly edited by Fr. Hartner. Stuttgart: A. Kröner. 320 pp. M. 12, bound M. 16. (C. A.)

45. GIBSON, WALCOT: **Coal in Great Britain.** London: Edward Arnold. 311 pp. 21s. (C. A.)

46. HERINGTON, C. F.: **Powdered Coal as a Fuel.** 2nd Ed. revized. New York: D. Van Nostrand Co. 338 pp. $4.50. For review see *Proc. Am. Soc. Civil Eng.*, **46**, 947 (1920). (C. A.)

47. LE CHATELIER, HENRY: **Le chauffage industriel.** Paris: Dunond. 536 pp. 36 fr. (C. A.)

48. Report of the Fuel Research Board for Years 1918 and 1919. London: Dept. of Scientific and Industrial Research by H. M. Stationery Office. 1s. 6d. For review see *Tech. Rev.*, **7**, 380 (1920). (C. A.)

See also Abs. Nos. 28, 29.

Abrasives

PATENT

49. Alumina; abrasives. CARBORUNDUM CO. Brit. 150,116, June 18, 1919. A fused Al_2O_3 for abrasive purposes, containing from 0.2–1.3% of TiO_2 and less than 0.8% each of Fe_2O_3 and SiO_2, is obtained by fusing in an elec. furnace a mixt. of aluminous material such as bauxite, clay, emery, etc., with enough C to obtain a product containing 90% of Al_2O_3, cooling, crushing, sepg. metallic particles, and again fusing the product with a small quantity of C sufficient to obtain the further reduction of impurities necessary to ob-

tain the production of the above-stated compn. Instead of using for the second fusion the product obtained by the first described treatment, waste or dust from Al_2O_3 which has been fused for abrasive purposes may be used, but in all cases C is employed in the final fusion. The product is used for abrasive purposes such as grinding wheels, and is preferably agglomerated by ceramic material. A suitable compn. is abrasive grains 80%, Albany clay or other fusible clay 14%, stoneware clay 5%, and feldspar 1%. This mixt. is burnt at 1350°. (C. A.)

See also Abs. No. 6.

White Ware and Porcelain

50. (Porcelain) insulation for high voltage transmission systems. ALFRED STILL. *Elec. Rev.*, **78,** 54–7 (1921).—In this instalment the fundamental laws of the dielec. circuit, dielec. strength of insulating materials, effect of condensers connected in series and the pin type insulator, are discussed.

C. G. F. (C. A.)

See also Abs. No. 57.

51. Pottery Industry of Swatow. ANON. *J. Royal Soc. Arts*, **69,** 18–19 (1920).—Chinaware, both coarse and fine, and pottery and earthenware, are made in Swatow, China, to supply a large portion of the local requirements, and are exported to the South Seas, the Strait Settlements, and Siam. The methods of manufacture are primitive and much of the chinaware is of inferior quality.

J. L. CRAWFORD

52. Japanese Pottery industry. ANON. *J. Royal Soc. Arts*, **68,** 716–18, 730–31 (1919).—The value of the porcelain and earthenware produced in Japan in 1918 was 44,214,084 yen (approximately £4,500,000). The relative production of the different classes of pottery for 1917 was as follows: Ornaments and art objects, 18%, dishes 56%, industrial goods 10%, toys 5%, miscellaneous, 11%. During the war the exports of pottery increased until the amount for 1918 had grown to four times the figure for 1914. The following classes of porcelain and semi-porcelain products, which are produced in quantity, enter largely into the export trade Tableware, sanitary ware, electrical porcelain, toys and novelties. A description of the industry is given.

J. L. CRAWFORD

Glass

53. Glass and some of its problems. SIR HERBERT JACKSON. *J. Royal Soc. Arts*, **68,** 134–46 (1920).—A popular lecture on glass and its manufacture. Among the topics discussed the following may be mentioned: The viscosity of glass at low temperatures; vitreous arsenic trioxide, sulphur, aqueous sodium acetate, aqueous Rochelle salt and zinc silicate; the effect of dissolved gases and other influences upon the devitrification of glass; the vitrifying influences of the oxides of Ti, Zr, Sn and Th; the production of opal glasses; the manufacture of colored glasses; and the behavior of MnO_2 in glass. Ed.

PATENTS

54. Mixing or comminuting and dissolving alkali silicates. F. J. PHILLIPS and E. J. ROSE. Brit. 151,508, Nov. 28, 1919. In mixing or comminuting and dissolving alkali silicates by agitating the partially disintegrated silicate in the presence of H_2O under the action of steam or gas in a rotary mixer, the steam or gas is arranged to be directed in the form of jets throughout the whole internal space of the mixer and to impinge with force upon the particles of the material treated. A suitable construction is specified. (C. A.)

55. Acid-proof buildings and structures. P. L. PFANNENSCHMIDT. Brit. 149,667, July 30, 1920. H_2SO_4 chambers or towers or any other structure for holding or conducting acid gases, are formed of a rigid acid-proof window-shaped framework in which are inserted sheets of acid-proof material such as quartz glass, enamel metal or glass. When using quartz-glass plates, a damaged plate may be mended by sticking a piece of quartz glass over it with water-glass putty. A suitable construction is specified. (C. A.)

56. Investigation of crystal structure by the Debye-Scherrer method. N. GROSS. *Umschau*, **34**, 510–4 (1920).—G. describes in a semi-popular article an app. for the investigation of crystal structure by means of X-rays on crystal powder. Quartz glass and gelatinous SiO_2 proved to be amorphous Cf. Hull, *C. A.*, **12**, 649. OTTO VON SCHLICHTEN

See also Abst. Nos. 25, 26.

Enamels

57. Commercial photometry. A. L. POWELL AND J. A. SUMMERS. *Gen. Elec. Rev.*, **24**, 50–8 (1921).—A review. A very useful bibliography is appended. C. G. F. (C. A.)

PATENTS

58. Protective treatment of iron blast furnace tuyères. SCHUSS GEBR., DAMPFKESSEL- UND APPARATE-BAUANSTALT. Ger. 319,938, May 31, 1918. The castings are coated with a highly refractory enamel. Any liquid Fe falling upon this surface flows off readily. (C. A.)

See also Abst. Nos. 27, 31, 55.

Cement, Lime and Plaster

59. Gypsum—properties, definition and uses. Bur. of Standards, *Circ.* **108.**—The uses of gypsum are discussed under the headings: Portland cement, fertilizers, plaster of Paris, wall, potter's and dental plasters, plate glass, cold-water paints, wood-fibered plaster, tile, plaster board, wall board, and Keene's cement. Recommended specifications for calcined gypsum, neat gypsum plaster, gypsum plaster board, and gypsum wall board are given in full.

A. J. LAMBERT

60. Fused cements and the electric furnace. J. BIED. *Rev. l'ingénieur*, **27**, 191–3 (1920).—Fused aluminous cements have approx. the formula:

$SiO_2.2CaO + 2(Al_2O_3.—CaO)$. These cements react to a very slight extent with sulfate waters. After 72 hrs. the strength of the mortar is equal to that of any artificial cement after three months. The curve of hardening of cement is not a parabola as is commonly assumed. (C. A.)

PATENTS

61. Slaking lime in a vertical container. C. E. CANDLAT. Ger. 323,519, Sept. 26, 1913. The H_2O used for slaking the lime is introduced within the CaO mass itself and in an amt. which corresponds to the lime discharged from the container. (C. A.)

62. Lime and like kilns. W. SOMERVILLE. Brit. 150,157, July 23, 1919. A lime or like kiln is provided with air inlets above the fire and with one or more uptakes communicating with the interior of the kiln below the burning zone, the draft being downwards, while the CO_2 or other gases pass away through the uptakes, draft being induced by air which enters at the foot of the kiln and is heated by the hot lime before entering the uptakes. Induced or forced draft may be used to assist in carrying off the CO_2. A suitable construction is specified. (C. A.)

63. Slag cements. R. BOVEROULLE. Brit. 149,988, Aug. 9, 1920. In making cement from slag by the cold process, lime dross, consisting of the residue of the lime which has passed through the grids beneath the kilns, together with ashes of the fuel employed, is mixed with granulated slag. (C. A.)

BOOKS

64. FRITSCH, J.: **Fabrication du ciment.** 2nd Ed. revized. Paris: Librairie scientifique et mèdicale, 93, Boulevard St. Germain. 550 pp. 45 fr. For review see *Mon. sci.*, **10**, 216 (1920). (C. A.)

BOOK REVIEWS

A Text Book of Chemical Engineering. By EDWARD HART, Chemical Publishing Co., Easton, Pa. 1920. Professor Hart's contributions to the acid industry, as well as his teaching experience, cause lively anticipation when a text on chemical engineering appears under his authorship. The present book is a rather small volume, profusely illustrated, as is shown by the list of 200 illustrations in the 206 pages of text. The illustrations are sometimes line drawings, but are frequently half tones taken from trade catalogs. There are chapters on *crushing*, dissolving, *filtration*, *tanks*, evaporation, crystallization, *drying*, distillation, absorption of gases, *mixing* and *kneading*, and *containers*. Although the book is a small one, it deals in an elementary way with subjects which are usually considered as belonging primarily in other divisions of engineering, such as *foundations*, *walls*, *floors*, *roofs*, *boilers*, and *prime movers*.

The treatment throughout is descriptive, with little attempt to develop the theory or its application to the industry. For instance, the chapter on evaporation contains eight illustrations of steam heated cast iron pans taken from one trade catalog. Both the illustrations and the description of multiple effect evaporators are stated to be copied directly from a trade catalog. The chapter on drying is also descriptive, with its material largely taken from trade catalogs and from standardized engineering handbooks. The book gives valuable descriptive information as to types of machinery used in the chemical industry and contains references to original articles and theoretical discussions appearing in literature.

ALFRED H. WHITE

ACTIVITIES OF THE SOCIETY

Actions taken by the Board of Trustees

February 7. It was voted that the Editor be allowed $100.00 a month for stenographic work, in addition to the necessary postage, stationery, and office supplies.

February 18. It was voted that the sum of $300.00, more or less as needed, be appropriated for the incidental expenses of the annual meeting.

Meetings of the Board Held During the Annual Meeting at Columbus

February 20. Those present were President R. H. Minton, R. K. Hursh, R. D. Landrum, M. F. Beecher, F. H. Riddle, R. T. Stull, with Charles F. Binns, Secretary, and Norah W. Binns, Assistant Secretary.

The minutes of the Board for the year were read and accepted.

The report to be presented by the Board to the Society was discussed and completed.

It was voted that the Treasurer be instructed to invest, at his discretion, in U. S. Treasury Certificates maturing in six months, and funds above the amount needed for current expenses.

It was voted that Mr. Riddle be requested to write an editorial for the Journal, on a code of ethics between employer and employee in the ceramic industry.

It was voted to recommend to the Rules Committee that the Nominating Committee consist of the two past presidents, and one representative elected by each industrial division and each local section, the Secretary of the Society to be chairman of this committee, without vote. Also that ten members of the Society, at least five of whom shall be Active Members, may form a self-constituted nominating committee and present a ticket of their own.

It was voted that the Board confirm, for 1920 and 1921, the action of August 4, 1919, that 10 per cent of the dues of a member of the Society, belonging to an industrial division, shall be allotted to his division for expenses in connection with the work of the division. In the case of a member who wishes to belong to more than one division, he shall designate his major division and 10% of his dues shall be allotted to that division.

It was voted that, in addition to the membership list arranged alphabetically a geographical list should be printed in the next Year Book.

Ninety-three Associates were elevated to Active Membership by vote of the Board.

February 22. It was voted that the position of Advertising Manager be added to the Committee on Publications, and that Mr. LeRoy W. Allison should be the present incumbent, without vote.

It was voted to contribute fifty dollars ($50.00) to the International Chemical Union toward the publication and distribution of the Annual Tables of Constants, Physical, Chemical, and Technological.

It was voted to appoint a committee of three to investigate and report fully upon the functions of the Society, the possibilities of development in coöperation and research, with a view to the appointment of a full-time Secretary.

February 23. It was voted that Charles F. Binns be re-appointed Secretary and Norah W. Binns, Assistant Secretary, for the years 1921–1922.

The appointment of Dr. E. W. Washburn as Editor of the Journal for the year 1921 was confirmed.

It was voted that all checks and cash received by the Secretary shall be recorded and transmitted direct to the Treasurer for deposit.

It was voted to increase the bond of the Treasurer from $5,000 to $20,000.

It was voted that the Local Sections and Industrial Divisions be requested to furnish a report of any activities to the Board on or before the first of each month, for publication in the Journal.

It was voted that the resolutions on the death of Ernest Mayer be given to the press on request.

The appointment of the Standing Committees by the President was confirmed by the Board.

Associates Elevated to Active Membership by Vote of the Board of Trustees at Columbus, Feb. 20

Agge, Franklin
Albery, D. F.
Allison, LeRoy W.
Ayars, E. E.
Bardush, J. F.
Barnes, T. R.
Booraem, J. Francis
Brockman, E. A.
Brown, Davis
Brown, Leslie
Brown, Wilbur F.
Brush, George S.
Buckner, O. S.
Carter, C. E.
Coulston, E. V.
Crawford, J. L.
Cruikshank, J. W.
Dains, I. F.
Denk, F. J.
Dewitt, Bert G.
Dixon, Henry L.
Douda, Henry W.
Dressler, Conrad
Eskesen, E. V.
Fettke, Charles R.
Foltz, Andrew
Footitt, F. Farnsworth
Forst, D. Parry
Fritz, E. H.
Fuller, Donald H.
Geisinger, E. E.
Geller, Roman F.
Gleason, Marshall W.
Goheen, John P.
Grafton, Charles O.
Grainer, John S.
Guastavino, R., Jr.
Harvey, F. A.
Hepplewhite, J. W.
Hess, Henry W.
Hostetter, J. C.
Jaeger, F. G.
Jones, Chester H.
Keeler, R. B.
Kent, G. G.
Kier, S. M.
Kimes, A. W.
Kingsbury, Percy C.
Krusen, I. A.
Kurtz, John C.
Lambie, J. M.
Lamont, R. A., Jr.
Libman, Earl E.
Manion, L. W.
Metzner, Otto
Moore, H. W.
Morey, George, W.
Mueller, Theodore E.
McKinley, J. M.
Pass, R. H.
Payne, A. R.
Peck, Albert B.
Post, M. P.

Ramsay, J. D.
Rochow, W. F.
Russel, John W.
Scholes, S. R.
Sharp, Chester L.
Shaw, L. I.
Solon, L. V.
Sortwell, H. H.
Stone, Charles H., Jr.
Strong, Thos. L.
Türk, Karl
Tyler, H. B.
Vollkommer, Josef
Vollrath, W. J.
Walton, S. F.
Weil, Edgar H.
Wilkins, Wm. W.
Wilkinson, George D.
Willetts, H. G.
Williams, Warren S.
Zopfi, Albert S.
Zwermann, Theodore

FOREIGN

Andersen, Olaf
Bigot, A.
Gibson, M. F.
Marson, Percival
Mellor, J. W.
Searle, Alfred B.
Shanks, Douglas
Tooth, W. E.

New Members received during February, 1921

Resident Associate

Boudreau, James C., 725 Fulton Bldg., Pittsburgh, Pa., Director of Art Education, Pittsburgh Board of Education.

Brownlee, Wm. L., Toledo, Ohio, Buckeye Clay Pot Company.

Day, O. L., 1513 Kirby Bldg., Cleveland, Ohio, Representative, Harbison-Walker Refractories Company.

Hull, W. A., Bureau of Standards, Washington, D. C., Chief, Optical Glass Division.

Kelly, M. J., 88 Van Dyke St., Brooklyn, N. Y., Vice-President and Manager Brooklyn Fire Brick Works.

Milford, L. R., Solvay Process Company, Syracuse, N. Y., Laboratory Manager.

O'Leary, T. A., 1212 Keenan Bldg., Pittsburgh, Pa., President, T. A. O'Leary Company and Enid Clay Company.

Smith, Charles A., 1150 Oak Street, Columbus, Ohio, Student, Ohio State University.

*__Speir, Oswald,__ One Madison Ave., New York City, Executive Secretary, National Terra Cotta Society.

Sutton, Willard J., 423 North Craig St., Pittsburgh, Pa., Graduate Student, University of Pittsburgh.

Weller, Samuel A., North Sixth St., Zanesville, Ohio, Owner, S. A. Weller Art Pottery Company.

Foreign Associate

Bianchedi, Romulo, Calle Junin 1028, Buenos Aires, Argentine, Head of Piccardo y Cia's Glass Works.

Curtis, Algernon Lewin, Westmoor Laboratory, Chatteris, Cambridgeshire England, Consulting Expert.

Corporation

Dings Magnetic Separator Company, Milwaukee, Wis.

W. S. George Pottery Company, East Palestine, Ohio

Gleason-Tiebout Glass Company, 99 Commercial St. Brooklyn N. Y.

*Deceased.

Minutes of the Third Annual Meeting of the Glass Division, Hotel Deshler, Columbus, Ohio, February 22, 1921

The meeting was called to order at 9.45 A.M. and in the absence of elected officers of the Division Mr. W. M. Clark was elected temporary Chairman. Thirteen papers dealing with various aspects of glass technology were presented and discussed.

Resolutions were passed extending the thanks of the Glass Division to Mr. E. F. Collins and Mr. Ward Harrison for their papers.

A resolution was passed suggesting that at the next meeting there be a special session in the afternoon with the Refractories Division on the subject of glass house refractories and other topics of common interest.

Nominations for officers of the Division were then called for and the following were declared elected:

Chairman, William M. Clark
Vice-Chairman, J. C. Hostetter.
Secretary, E. W. Tillotson.
Councillors, H. S. Dixon, C. O. Grafton.

A vote was then taken on the following amendments to the by-laws which being favorable the by-laws were declared adopted.

Amendment of article VII, Committees—paragraph 1—strike out the word "council" and insert the word "Chairman" so that it shall read: "the chairman of the Division shall from time to time appoint such committees, etc."

Amendment of article VII, Committees—paragraph 2—"At the regular business meeting of the Division nominations may be made of one member for each of the several standing committees of the American Ceramic Society. Such nominees when appointed on a committee of the Society shall serve as chairman of the corresponding divisional committees (the present standing committees are those on Research and Development, Rules, Coöperation, Standards, Sections and Division and Membership. See THIS JOURNAL, November, **1920**, page 944).

In conformance with provisions of article VII, paragraph 2, the following nominations for committees were made:

Rules, R. J. Montgomery.
Coöperation, G. W. Morey.
Membership, H. W. Hess.
Standards, A. Silverman.
Sections and Divisions, J. W. Cruikshank.

A letter from Dr. W. E. S. Turner was read extending an invitation for a joint conference in England in 1922. It was voted that the committee be appointed to investigate the cost of the trip and to canvas the membership to determine how many might be interested.

The U. S. Bureau of Standards' Specifications on Limestone, etc., was referred to the Committee on Standards.

It was suggested that the report on specifications for glass house refractories

presented last year be revised and published after having canvassed the Division for an opinion concerning the several paragraphs of the report.

The meeting adjourned at 4.00 P.M. with about fifty members present.

EDWARD TILLOTSON
Secretary of the Glass Division

Minutes of the Organization Meeting of The Art Division

The Ceramic Decorative Processes Division held its first meeting at the twenty-third annual convention of the Society at the Deshler Hotel on Tuesday, February 23. Mr. Wm. W. Wilkins, Chicago, Ill., was made temporary chairman. The following papers were read:

"The Mutual Relation of Art and Technics in Our Industry," Leon V. Solon, Art Director, American Encaustic Tiling Co., New York.

"Relation of the Artist to the Manufacturer," Conrad Dressler, sculptor, potter, inventor of the Dressler Tunnel Kiln, Cleveland, Ohio.

"Some Suggestions for Research in Commercial Ceramic Decorative Processes," Frederick H. Rhead, Director Research, American Encaustic Tiling Co., Zanesville, Ohio.

Following a discussion in regard to the name of this Division it was proposed by Mr. John W. Hasburg and seconded by Mr. Leon V. Solon that the new division be named THE ART DIVISION of the American Ceramic Society. The following officers were elected: Frederick H. Rhead, Zanesville, Ohio, chairman; R. Guy Cowan, Cleveland, Ohio, vice-chairman; Mabel C. Farren, Pittsburgh, Pa., secretary-treasurer; Mr. Leon V. Solon was elected councillor for the architectural, faience, and Terra Cotta treatments. The election of the remaining councillors was postponed until later.

There was some discussion in regard to proposed activities for the coming year. Efforts are to be made to interest manufacturers and those interested in the educational side of the work, studio potters, and the practical workers in the pottery industry. These elements are vitally concerned in the program of THE ART DIVISION.

It was proposed and seconded that a tentative program be made and submitted at an early date for the consideration of the members. The various interests mentioned are to be then approached, and their consideration and suggestions sought.

In conclusion, it was decided that the principal activities for the first year were to be along the direction of including in the membership the various allied activities, and the educational element not yet connected with the Society and also to have an exhibit which will be passed upon by a jury to be named later.

A vote of thanks was given to Miss Margaret Cable for the very interesting exhibit of pottery work which was made under her direction at the University of North Dakota.

FREDERICK H. RHEAD
Temporary Secretary

JOURNAL AMERICAN CERAMIC SOCIETY

Preparation of Abstracts

Every article in THIS JOURNAL is to be preceded by an abstract prepared by the author and submitted by him with the manuscript. The abstract is intended to serve as an aid to the reader by furnishing an index and brief summary or preliminary survey of the contents of the article; it should be suitable for reprinting in an abstract journal so as to make a reabstracting of the article unnecessary. The abstract should, therefore, **summarize all new information completely and precisely.** Furthermore, in order to enable a reader to tell at a glance what the article is about and to enable an efficient index of its subject matter to be readily prepared, the abstract should contain **a set of subtitles** which together form a **complete and precise** index of the information contained in the article. This requires at least one and often several subtitles even for a short abstract.

In the preparation of abstracts, authors should be guided by the following rules, which are illustrated by the abstracts in THIS JOURNAL for February and March, 1921.* The **new information** contained in an article should first be determined by a careful analysis; then the subtitles should be formulated; and finally the text should be written and checked.

Rules

1. **Material not new** need not be analyzed or described in detail; a valuable summary of a previous work, however, should be noted with a statement indicating its nature and scope.

2. **The subtitles should together include all the new information;** that is every measurement, observation, method, improvement, suggestion and theory which is presented by the author as new and of value in itself.

3. **Each subtitle should describe the corresponding information so precisely** that the chance of any investigator being misled into thinking the article contains the particular information he desires when it does not, or vice-versa, may be small Such a title as "A note on blue glass," for example, is evidently too indefinite a description of information regarding "Absorption spectra of glass containing various amounts of copper-cobalt and chromium-cobalt." General subtitles, such as "Purpose" and "Results" should not be employed as they do not help to describe the specific information given in the article.

4. **The text should summarize the authors' conclusions and should transcribe numerical results of general interest,** including those that might be looked for in a table of physical and chemical constants, with an indication of the accuracy of each. It should give all the information that anyone, not a specialist in the particular field involved, might care to have in his note book.

5. **The text should be divided into as many paragraphs as** there are distinct subjects concerning which information is given, but no more than necessary. All parts of subtitles may be scattered through the text but the subject of each paragraph, however short, must be indicated at the beginning.

6. **Complete sentences** should be used except in the case of subtitles. The abstract should be made as readable as the necessary brevity will permit.

7. The ms. of all abstracts must be typewritten and double or triple spaced.

* The rules were prepared by the Research Information Service of the National Research Council. The Society is indebted to Dr. G. S. Fulcher of the Corning Glass Works (formerly with the National Research Council) for the rules and the illustrative abstracts.

AMERICAN CERAMIC SOCIETY

OFFICERS, 1921-1922

President: F. K. Pence, American Encaustic Tile Co., Zanesville, Ohio.
Vice-President: Fred B. Ortman, 2525 Clybourn Ave., Chicago, Ill.
Treasurer: R. K. Hursh, University of Illinois, Urbana, Ill.
Secretary: C. F. Binns, Alfred University, Alfred, N. Y.
Board of Trustees: The President, Vice-President, Treasurer, and R. M. Howe, M. F. Beecher, F. H. Riddle, R. H. Minton, and R. T. Stull.

CORPORATION MEMBERS, 1920-1921

Abrasive Company.
Aexander Hamilton Inst.,
American Dressler Tunnel Kilns, Inc.
American Emery Wheel Works.
American Encaustic Tiling Co.
American Terra Cotta & Ceramic Co.

Bausch & Lomb Optical Co.
Beaver Falls Art Tile Co.
Benjamin Electric Mfg. Co.
Bird and Company
Brick and Clay Record.
Buckeye Clay Pot Co.
W. G. Bush and Co.

Canton Stamping & Enameling Co.
Carborundum Co.
Champion Ignition Co.
Colonial Co.
Consolidated Window Glass Co.
Coonley Manufacturing Co.
Cortland Grinding Wheel Co.

H. L. Dixon Co.
B. F. Drakenfeld & Co., Inc.
Dunn Wire Cut Lug Brick Co.
East Liverpool Potteries Co.
Edgar Plastic Kaolin Co.
Edward Ford Plate Glass Co.
Elyria Enameled Products Co.
Findlay Clay Pot Co.
Foote Mineral Co.

French China Co.
Frink Pyrometer Co.
Gillinder Brothers.
Golding Sons Co.
The Glass Worker.

Hall China Co.
Hanovia Chemical & Mfg. Co.
Harbison-Walker Refractories Co.
Harker Pottery Co.
Harshaw-Fuller & Goodwin Co.
Homer Laughlin China Co.
L. J. Houze Convex Glass Co.

Illinois Glass Co.

Jefferson Glass Co.
Jeffery-Dewitt Co.
Johnston Brokerage Co.
Jones Hollow Ware Co.

Edwin M. Knowles China Co.
Knowles, Taylor, and Knowles Co.
Laclede-Christy Clay Products Co.
Limoges China Co.
A. J. Lindemann & Hoverson Co
Lindsay Light Co.
Los Angeles Pressed Brick Co.
Louthan Manufacturing Co.

Macbeth-Evans Glass Co.
Maine Feldspar Co.
F. Q. Mason Color and Chemical Co.
Massillon Stone and Fire Brick Co.
Maxf Grinding Wheel Corporation.
Midland Terra Cotta Co.
Monongah Glass Co.
Mosaic Tile Co.
D. E. McNicol Pottery Co.
T. A. McNicol Pottery Co.

Nat'l. Fire Proofing Co.
Norton Co.

Ohio Pottery Co.
Onondaga Pottery Co.
Owen China Co.

Pennsylvania Salt Mfg. Co.
Perth Amboy Tile Co.
Pfaudler Co.
Philadelphia Drying Machinery Co.
Philadelphia Quartz Co.
Phoenix Glass Co.
Pittsburgh High Voltage Insulator Co
Pittsburgh Plate Glass Co.
Potters Supply Co.

Reliance Firebrick and Pottery Co., Ltd.
Roessler & Hasslacher Chemical Co.

John H. Sant & Sons Co.
Saxon China Co.
Sebring Pottery Co.
Smith-Phillips China Co.
Standard Pottery Co.
Standard Sanitary Manufacturing Co.
Star Porcelain Co.
Steubenville Pottery Co.
Streator Clay Mfg. Co.
Square D. Co., Peru, Ind.

Taylor, Smith & Taylor Co.
N. Thomas & Sons Co.
Trenton Flint & Spar Co.

United States Glass Co.
United States Smelting Furnace Co.

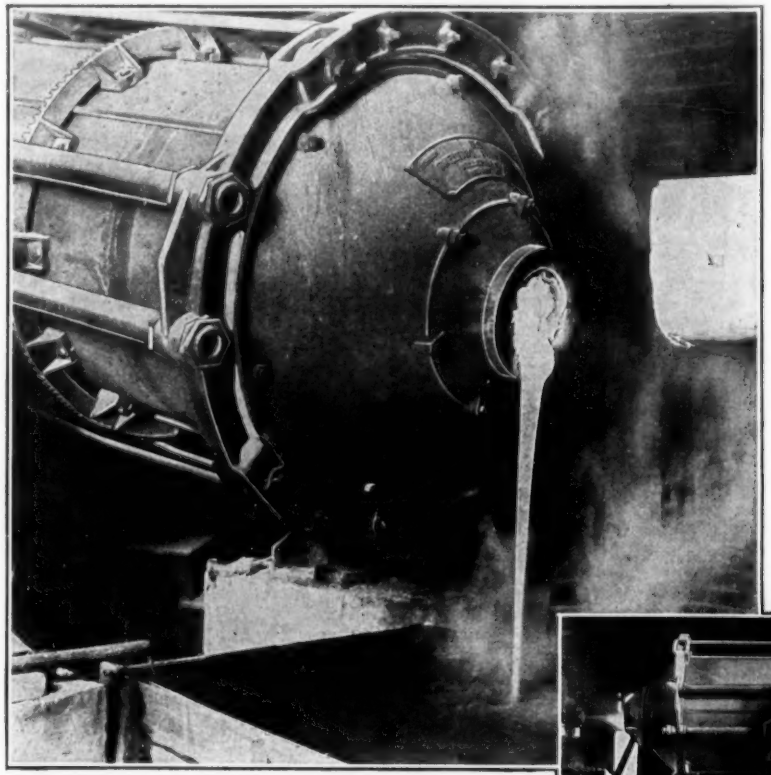
Veritas Firing System.
Vitro Manufacturing Co.
Vodrey Pottery Co.

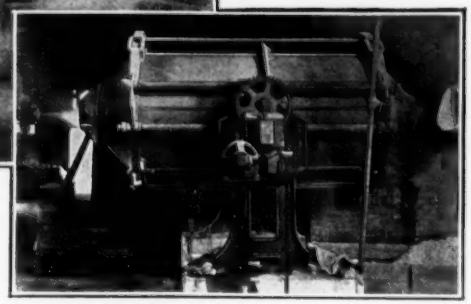
Warwick China Co.
West End Pottery Co.
Western Stoneware Co.

COMMITTEE ON MEMBERSHIP

F. H. Riddle, *Chairman*
Jeffrey-Dewitt Co.
Detroit, Mich.

BELLEVILLE, ILLINOIS





These illustrations made from photographs taken in the plant of Ingram-Richardson Mfg. Co., Beaver Falls, Pa.

"Our U. S. Enamel Furnaces Increase Output 25% per day at a Saving of 50% in Fuel Cost."

Ingram-Richardson Mfg. Company claim those remarkable results for their U. S. Enamel Furnaces. With four U. S. Furnaces operating at their plants at Frankfort, Indiana, and Beaver Falls, Pa., they are saving thousands of dollars yearly in fuel and labor.

Their white and colored enamels are smelted in quick time, with low loss. The work is easy and sure. The Furnace is under perfect scientific control. The melting process is visible. The Furnace rotates while melting and tilts when pouring. Linings last longer and cost less.

The U. S. Enamel Furnace is saving money over the old brick smelter in the Ingram-Richardson Mfg. Company plant. It will do the same for you.

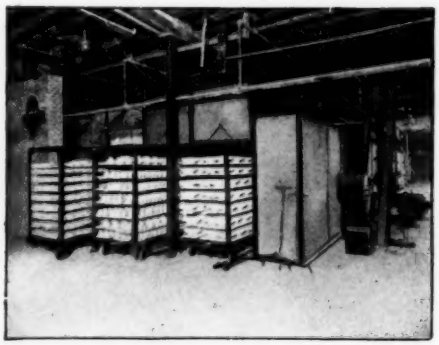
Let the U. S. Furnace melt your enamel.

Write for specifications and prices on 60 lb., 150 lb., 400 lb., 750 lb., and 1200 lb. Enamel Furnaces. We will send photographs and list of users where furnaces are in operation.

THE
U. S. SMELTING FURNACE CO.
BELLEVILLE, ILLINOIS

"HURRICANE" DRYERS

For Clay and Porcelain Products



Tunnel Truck Dryer for Insulators

QUICK DRYING, LESS COST

There is a "Hurricane" Dryer to efficiently and economically handle practically every Clay and Porcelain product.

This "Hurricane" Tunnel Truck Dryer cut a week from the manufacturing Schedule in one of the largest insulator plants in the country.

Chinaware can be dried uniformly and without waste in one hour in a "Hurricane" Automatic Stove Room. Think of the enormous advantage of being able to have your ware made, dried and ready for the kiln in one and a half hours, or even less.

Dipped ware, when handled by the old stillage room method, often requires 24 hours to dry. It takes about 20 minutes with the "Hurricane" Automatic conveyor type of Mangle.

You will be surprised to know the short time it takes to "condition" spark plug blanks or clay rolls to the leather hard condition. Let us tell you about the "Hurricane" Conditioning Machine.

Besides greatly reducing costs by shortening the drying time "Hurricane" Dryers require a minimum of floor-space, assure a uniform product, and reduce labor expense.

Automatic Dryer for Spark Plug Blanks

Truck and Automatic Systems

The Philadelphia Drying Machinery Co.

Main Office and Works
3351 Stokley St.

Philadelphia

Boston Office
53 State St.

BUYERS' GUIDE

Acid and Heat Resisting Material
General Ceramics Co.
Air Compressors
General Electric Co.
Alternators
General Electric Co.
Alumina (Hydrate and Calcined)
Pennsylvania Salt Mfg. Co.
Auger Machines
Chambers Brothers Co.
Crossley Machine Co.
Manufacturers Equipment Co.
Automatic Cutters
Chambers Brothers Co.
Automatic Stove Rooms
Philadelphia Drying Mch. Co.
Ball Mills
Abbé Engineering Co.
Crossley Machine Co.
Blowers (Pressure)
Abbé Engineering Co.
Boiler Insulation
Celite Products Co.
Bolting Cloth
Abbé Engineering Co.
Brick (Insulating)
Celite Products Co.
Brick Making Machinery
Chambers Brothers Co.
Caustic Soda
Pennsylvania Salt Mfg. Co.
Cement (Insulating)
Celite Products Co.
Ceramic Plant Equipment
Abbé Engineering Co.
Chambers Brothers Co.
Crossley Machine Co.
Philadelphia Drying Machinery Co.
Proctor and Schwartz, Inc.
Manufacturers Equipment Co.
Ceramic Chemicals
Drakenfeld Co., B. F.
Harshaw, Fuller and Goodwin Co.
Paper Makers Chemical Co.
Roessler and Hasslacher Chemical Co.
Vitro Mfg. Co.
Clays (China)
Edgar Brothers Co.
Drakenfeld and Co., B. F.
Paper Makers Chemical Co.
Clay (Electrical —Porcelain)
Edgar Brothers Co.
—Paper Makers Chemical Co.
Clay (Fire)
Edgar Brothers Co.
Paper Makers Chemical Co.
Grand View Fire Clay Mines
Clay (Sagger)
Edgar Brothers Co.
Grand View Fire Clay Mines
Paper Makers Chemical Co.
Clay Handling Machinery
Crossley Machine Co.
Hadfield-Penfield Steel Co.
Manufacturers Equipment Co.
Clay Miners
Edgar Brothers Co.
Grand View Fire Clay Mines
Clay Washing Machinery
Crossley Machine Co.
Clay Working Machinery
Abbé Engineering Co.
Crossley Machine Co.
Hadfield-Penfield Steel Co.
Manufacturers Equipment Co.
Colors
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Roessler and Hasslacher Chemical Co.
Vitro Mfg. Co.
Conditioning Machinery
Philadelphia Drying Machinery Co.
Conical Mills
Abbé Engineering Co.
Crossley Machine Co.
Hadfield-Penfield Steel Co.
Conveyors (Clay, Sand, Brick, etc.)
Crossley Machine Co.
Hadfield-Penfield Steel Co.
Philadelphia Drying Machinery Co.
Manufacturers Equipment Co.
Controllers (Automatic Temperatures)
Charles Engelhard
Controllers (Electric)
General Electric Co.
Crushers
Abbé Engineering Co.
Chambers Brothers Co.
Crossley Machine Co.
Hadfield-Penfield Steel Co.
Manufacturers Equipment Co.
Decorating Supplies
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Roessler and Hasslacher Chemical Co.
Vitro Mfg. Co.
Disintegrators
Abbé Engineering Co.
Chambers Brothers Co.
Crossley Machine Co.
Hadfield-Penfield Steel Co.
Manufacturers Equipment Co.
Doors (Kiln-Dryer)
Manufacturers Equipment Co.
Draft Gauges
Brown Instrument Co.
Dryers (China Ware-Porcelain)
Philadelphia Drying Machinery Co.
Proctor and Schwartz, Inc.
Russel Engineering Co.
Dryers (Radiated Heat)
Manufacturers Equipment Co.
Drying Machinery
Crossley Machine Co.
Philadelphia Drying Machinery Co.
Proctor and Schwartz, Inc.
Manufacturers Equipment Co.
Electrical Instruments
Brown Instrument Co.
Charles Engelhard
Electrical Porcelain Machinery
Crossley Machine Co.
Enameling Furnaces
U. S. Smelting Furnace Co.
Engineering Service
Abbé Engineering Co.
Crossley Machine Co.
Chambers Brothers Co.
Hadfield-Penfield Steel Co.
Manufacturers Equipment Co.
Philadelphia Drying Machinery Co.
Proctor and Schwartz, Inc.
Russell Engineering Co.
Equipment (Electrical)
General Electric Co.
Extruding Machines (Lab. Use)
Chambers Brothers Co.
Feldspar
Drakenfeld and Co., B. F.
Harshaw Fuller and Goodwin Co.
O'Brien and Fowler
Filtering Machinery
Abbé Engineering Co.
Crossley Machine Co.
Furnaces
U. S. Smelting Furnace Co.
Gold
Harshaw, Fuller and Goodwin Co.
Roessler and Hasslacher Chemical Co.
Glazes and Enamels
Harshaw, Fuller and Goodwin Co.
Roessler and Hasslacher Chemical Co.
Vitro Manufacturing Co.
Ilmenite
Buckman and Pritchard, Inc.
Impervite (Refractory and Hard Porcelain)
Charles Engelhard
Jar Mills
Abbé Engineering Co.
Jiggers
Crossley Machine Co.
Hadfield-Penfield Steel Co.

We Have Faith in Our Goods so We Advertise Here——

The Underwood Producer Gas System, patented, saves fuel and labor in burning clayware, baking carbon products, roasting ores, heating lehrs in glass factories, also revolving pots, etc., and enameling metal ware.

The Justice Radiated Heat and Waste Heat Dryers for drying structural clayware have no equal in economy and efficiency.

"Meco" Single Roll Rock and Shale Crushers, Elevators, conveyors, and feeders make up the most complete clay preparing outfit, a necessity in every clay plant when material must be ground and screened. Write us about these things. To answer is our pleasure.

THE MANUFACTURERS EQUIPMENT CO.

Dayton, Ohio, U. S. A.

SOLE IMPORTERS OF

KRYOLITH GENUINE **GREENLAND**

FOR THE GLASS AND ENAMEL TRADES

MANUFACTURERS OF

NATRONA HYDRATE and OXIDE

FOR THE GLASS, ENAMEL AND PORCELAIN TRADES

ALUMINA

And Other INDUSTRIAL CHEMICALS

Pennsylvania Salt Manufacturing Co.

MAIN OFFICES: PHILADELPHIA

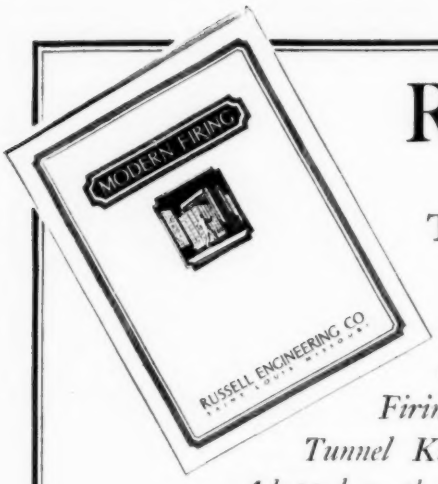
615 UNION ARCADE BLDG. PITTSBURGH, PA.

BUYERS' GUIDE (continued)

Kaolin
Edgar Plastic Kaolin Co.
Harshaw, Fuller and Goodwin Co.
Kiln Insulation
Celite Products Co.
Kryolith
—Pennsylvania Salt Mfg. Co.
Laboratory Mills
Abbé Engineering Co.
Crossley Machine Co.
Mills (*See under Ball Mills*)
(*See under Pebble Mills*)
Minerals
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Roessler and Hasslacher Chemical Co.
Mixing Machines
Chambers Brothers Co.
Motors (Electrical)
General Electric Co.
Muriatic Acid
Harshaw, Fuller and Goodwin Co.
Pennsylvania Salt Mfg. Co.
Roessler and Hasslacher Chemical Co.
Oxides
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Paper Makers Chemical Co.
Pennsylvania Salt Mfg. Co.
Roessler and Hasslacher Chemical Co.
Pans (Wet and Dry)
Chambers Brothers Co.
Crossley Machine Co.
Hadfield-Penfield Steel Co.
Manufacturers Equipment Co.
Pebble Mills
Abbé Engineering Co.
Crossley Machine Co.
Hadfield-Penfield Steel Co.
Plate Feeders
Chambers Brothers Co.
Crossley Machine Co.
Hadfield-Penfield Steel Co.
Manufacturers Equipment Co.
Porcelain Balls and Lining
Abbé Engineering Co.
Pottery Machinery
Abbé Engineering Co.
Crossley Machine Co.
Hadfield-Penfield Steel Co
Manufacturers Equipment Co.
Pulverizing Machinery
Abbé Engineering Co.
Crossley Machine Co.
Hadfield-Penfield Steel Co.
Manufacturers Equipment Co.
Producer Gas Burning Systems
Manufacturers Equipment Co.
Pressure Measuring Instruments
Brown Instrument Co.
Pumps
Abbé Engineering Co.
Pug Mills
Chambers Brothers Co.
Crossley Machine Co
Hadfield-Penfield Steel Co.
Manufacturers Equipment Co.
Pyrometers (Indicating)
Brown Instrument Co.
Charles Engelhard
Pyrometers (Recording)
Brown Instrument Co
Charles Engelhard
Pyrometer Tubes (Refractory and Hard Porcelain)
Charles Engelhard
Montgomery Porcelain Products Co.
Recording Instruments
Brown Instrument Co.
Charles Engelhard
Refractory Materials
Buckman and Pritchard, Inc.
Regulators (Automatic Temperatures)
Charles Engelhard
Rutile
Buckman and Pritchard, Inc.
Sagger Presses
Chambers Brothers Co.
Crossley Machine Co.
Hadfield-Penfield Steel Co.
Selenite of Sodium
Drakenfeld and Co., B. F.
Vitro Mfg. Co.
Silica (Fused)
General Ceramics Co.
Silex Lining
Abbé Engineering Co.
Smelters
U. S. Smelting Furnace Co.
Sulphuric Acid
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Pennsylvania Salt Mfg. Co.
Roessler and Hasslacher Chemical Co.
Temperature Instruments (Measuring)
Brown Instrument Co.
Charles Engelhard
Thermometers (Electric Resistance)
Brown Instrument Co.
Charles Engelhard
Tile Machinery (Floor and Wall)
Crossley Machine Co.
Tubes (Insulating)
Montgomery Porcelain Products Co.
Tubes (Pyrometer)
Charles Engelhard
Montgomery Porcelain Products Co.
Tube Mills
Abbé Engineering Co.
Tunnel Kilns
Russell Engineering Co.
Vacuum Pumps
Abbé Engineering Co.
Waterproofing Materials
Celite Products Co.
Whiting
Drakenfeld and Co., B. F.
Harshaw, Fuller and Goodwin Co.
Roessler and Hasslacher Chemical Co.
Zircon (Miners of)
Buckman and Pritchard, Inc.
Zirconium Silicate (Fire Cement)
Buckman and Pritchard, Inc.
Zirconium Silicate (Refined)
Buckman and Pritchard, Inc.

ALPHABETICAL LIST OF ADVERTISERS

	PAGE
(1) Abbé Engr'g Co., Inside front cover	
(2) Brown Instrument Co.	9
(3) Buckman and Pritchard, Inc.	14
(4) Celite Products Co.	13
(5) Chambers Brothers Co.	6
(6) Crossley Machine Co.	13
(7) Drakenfeld and Co., B. F.	11
(8) Edgar Brothers Co.	9
(9) Engelhard, Charles	12
(10) General Ceramics Co.	—
(11) General Electric Co. Outside back cover	
(12) Grand View Fire Clay Mines	7
(13) Hadfield-Penfield Steel Co.	7
(14) Harshaw, Fuller and Goodwin Co., Inside back cover	
(15) Manufacturers Equipment Co.	4
(16) Montgomery Porcelain Products Co.	6
(17) O'Brien and Fowler	7
(18) Paper Makers Chemical Co.	10
(19) Pennsylvania Salt Mfg. Co.	4
(20) Philadelphia Drying Mch'y Co.	2
(21) Proctor and Schwartz, Inc.	7
(22) Roessler and Hasslacher Chem. Co.	8
(23) Russell Engineering Co.	6
(24) U. S. Smelting Furnace Co.	1
(25) Vitro Manufacturing Co.	10



RUSSELL

(Zwermann Patents)

TUNNEL KILNS

This New Book is a Treatise on the Scientific and Modern System for Firing all Clay Wares in the Tunnel Kiln. The Russell Kiln is Adapted to the use of Producer Gas, Oil or Natural Gas as Fuel.

*A Copy of "*MODERN FIRING*" Awaits Your Request*

RUSSELL ENGINEERING CO.
RAILWAY EXCHANGE BUILDING ST. LOUIS, MO.

If you want the best, buy or specify
MONTGOMERY HARD PORCELAIN PYROMETER TUBES
All Sizes and Lengths for Either Rare or Base Metal Couples

1. Can be used to 1600 C–2900 F.
2. No glaze to stick or to be absorbed by a porous body.
3. Body vitreous and absolutely impervious to gases.
4. Notably resistant to sudden temperature changes.
5. Trade-marked for identification.
6. Made with or without collars or flanges.
7. Prices reasonable – – Deliveries quick.
8. Threaded brass couplings cemented to tubes if desired.
9. Sold direct from the factory or through the manufacturer of your Pyrometer Equipment.
10. Write us for quotation on tubes for replacement, stating the size tube you use and length.

TRADE MARK

MONTGOMERY PORCELAIN PRODUCTS CO.
Franklin, Ohio, U. S. A.

BRICK MAKING MACHINERY

OF THE STRONGER AND BETTER CLASS

We specialize on Dies and Augers and to their adaptation to individual requirements. Automatic Cutters up to 12000 bricks per hour Capacity.

CHAMBERS BROS. CO. Fifty-Second Street Corner of Media **Philadelphia, Pa.**

THE HADFIELD PENFIELD STEEL CO.
BUILT RIGHT RUN RIGHT
BUCYRUS OHIO

CLAY PLANT EQUIPMENT

We build every machine and appliance required for making various Clay Products. Correspondence solicited. We also build Rotary Driers, Cement Mchy. Fuel Oil Engines (Diesel Type), Gasoline Locomotives, Ship Deck Equipment, etc.

The Hadfield-Penfield Steel Co., Bucyrus, Ohio.

Formerly The American Clay Mchy. Co.

"Proctor" DRYERS

Electrical Porcelain, General Ware, Sanitary Ware, Tile, Brick and other clay Products are dried by "Proctor" Dryers with results superior in quality, efficiency and economy. Let us send you our catalogue.

PROCTOR & SCHWARTZ, Inc. Philadelphia, Pa.

HIGH GRADE MISSOURI FIRE CLAYS

ZINC SPELTER, GLASS HOUSE AND FURNACE CLAYS

Grand View Fire Clay Mines

A. A. Vancleave, Proprietor

Office and Mines: 5021 Fyler Avenue **St. Louis, Mo.**

FELDSPAR

CRUDE, EXTRA FINE, SELECTED MINERAL.

A service direct to particular potters.

DENTAL POTTERY GLASS

O'BRIEN & FOWLER

511 Union Bank Building

OTTAWA **CANADA.**

"AMERICA'S LEADING CERAMIC MATERIAL HOUSE"

QUALITY

IS THE MEASURE OF

VALUE

THE ROESSLER & HASSLACHER CHEMICAL CO.

NEW YORK, N. Y.

CHICAGO
BOSTON
NEW ORLEANS

CLEVELAND
PHILADELPHIA
TRENTON
SAN FRANCISCO

CINCINNATI
KANSAS CITY
AKRON

Standard Economizer of the Brick Industry

SAVES 1/3 FUEL

Accurate control of temperature in firing kilns, for burning brick, terra-cotta, tile, sewer pipe, etc., means a greater percentage of 1st class ware produced,—less fuel consumption and a saving of ⅓ time for burning.

Let our engineers tell you what you can save. Write today for catalog No. 62., on Recording Thermometers for Dryers. Address the Brown Instrument Co., 4513 Wayne Ave., Philadelphia, Pa.

Brown Pyrometers

Quality *Uniformity* *Experience*

Edgar QUALITY *Clays*

REALLY washed—Highest percentage clay substance

Brands	*Produced by*
Edgar Florida Kaolin	*Edgar Plastic Kaolin Co.*
Edgar Georgia Paper Clay and Kaolin	*Edgar Brothers Co.*
Lake County Florida Clay	*Lake County Clay Co.*

One Management—Office, Metuchen, N. J.

NEW PRICES

TRANSACTIONS OF THE AMERICAN CERAMIC SOCIETY

The following volumes may be obtained singly:

Vol.	I	$4.75
"	III	4.75
"	VII	6.50
"	XIII	6.50
"	XVI	8.00
"	XVII	8.00

A complete set, minus Vols. IX, XII, and XIX which are out of print, may be obtained at a cost of $150.00, with 40% discount to members of the Society.

Charles F. Binns, Secretary

Alfred, New York

ENGLISH
AND
DOMESTIC

CLAYS
FOR
ALL
CERAMIC
PURPOSES

—PMCCO—
MEANS SERVICE, QUALITY AND PRICE

PAPER MAKERS CHEMICAL CO. EASTON, PA.

VITRO
CHEMICALS

SELENITE of SODIUM

ARTIFICIAL CRYOLITE
for white and opalescent glass

SODIUM SILICO FLUORIDE

UNDERGLAZE COLORS
for high temperatures

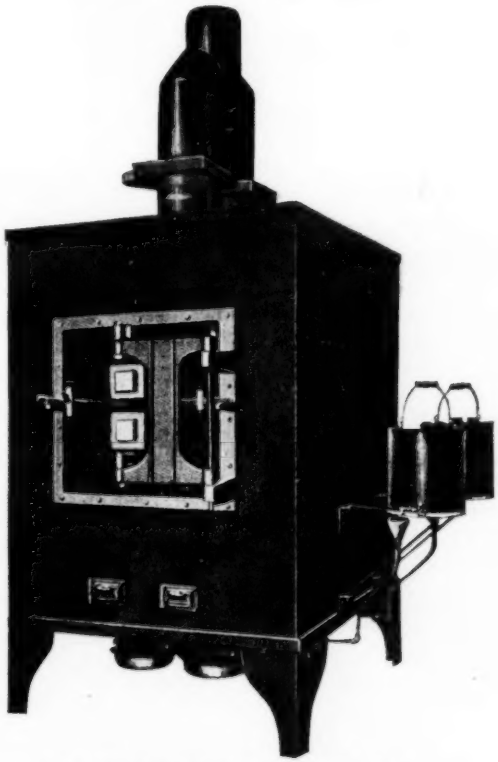
POTTERY GLAZES & ENAMELS

The Vitro Mfg. Co. Pittsburgh, Pa.

PERFECTION POTTERY KILNS

FOR FIRING BUSCUIT, CLAY BODIES AND GLAZES

EQUIPPED FOR KEROSENE OIL,
MANUFACTURED AND NATURAL GAS

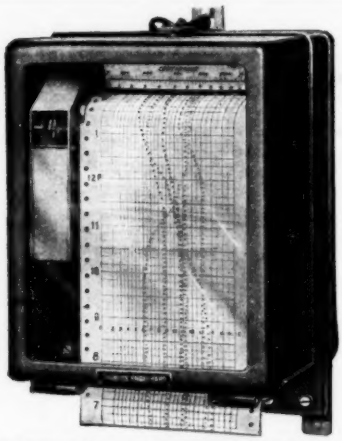


NO. 12 PERFECTION POTTERY KILN
Equipped With Kerosene Oil Burners

B. F. DRAKENFELD & CO., Inc.

50 MURRAY STREET NEW YORK, N. Y.

ILLUSTRATED CATALOG MAILED ON REQUEST



ENGELHARD MULTIPLE RECORDER

KEEP THE TEMPERATURE INCREASING!

1st Watersmoking—temperature increasing very slowly.

2nd Watersmoking to carbonizing—UP QUICKLY.

3rd Carbonizing—a critical range.

4th Carbonizing to vitrification — UP QUICKLY.

5th Vitrification—temperature must be held but not exceeded.

ENGELHARD PYROMETERS

enable you to know and control the temperatures in your kilns. They are accurate, simple, durable and *you can depend on them.* Many ceramic plants will tell you that

ENGELHARD PYROMETERS ARE GOOD PYROMETERS TO STANDARDIZE ON.

CHARLES ENGELHARD, INC.

30 Church St., **New York City**

Why Do You Blanket Your Auto Radiator in Zero Weather?

The first thing a careful motorist usually does after he stops his engine on a zero night is to blanket the radiator. Unknowingly, he does that for the same reason that the carefully thinking engineer blankets his ceramic kilns with SIL-O-CEL—namely to prevent heat radiation.

Insulation of kilns with SIL-O-CEL prevents the escape of 60% to 70% of the heat which ordinarily goes to waste. It keeps the maximum amount of heat, evenly distributed, at work inside the kilns. SIL-O-CEL prevents the formation of cool spots which cause some pieces to be underburned.

Insulation with SIL-O-CEL has conclusively proven its ability to keep more heat units working out of a certain amount of fuel. It means a more evenly heated Kiln from less fuel. Our booklet A-5-A will give detailed data. Send for a copy.

CELITE PRODUCTS COMPANY

NEW YORK, 11 BROADWAY · CLEVELAND, GUARDIAN BLDG · ST. LOUIS, 1532 OLIVE STREET
PHILADELPHIA, LIBERTY BLDG · DETROIT, BOOK BUILDING · LOS ANGELES, VAN NUYS BLDG
PITTSBURGH, OLIVER BLDG · CHICAGO, MONADNOCK BLOCK · SAN FRANCISCO, MONADNOCK BLDG

SIL-O-CEL

PREVENTS HEAT PENETRATION

TRADE MARK REGISTERED U.S. PATENT OFFICE

4 ft. style "B" Dry Pan

We are engineers to the clay-worker

We have been in business since 1879.

You are invited to benefit by our extensive service. Our catalog will interest you. Write for it.

The Crossley Machine Company

Trenton, N. J.

ZIRCON

Small amounts in porcelain, glazes and enamels, increase their dielectric and mechanical strength and resistance to sudden and extreme changes of temperature.

There will be more B. & P. Zircon used in 1921 than the combined uses of all other forms of Zirconium of all times.

IT'S IRON FREE

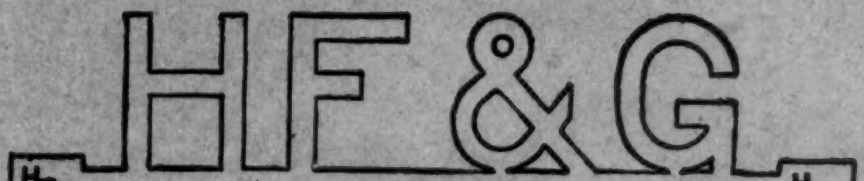
BUCKMAN & PRITCHARD, INC.

MINERS AND MANUFACTURERS

MINERAL CITY, FLORIDA

New York Office, 94 Fulton Street

Chicago Office, 1350 Peoples Gas Building



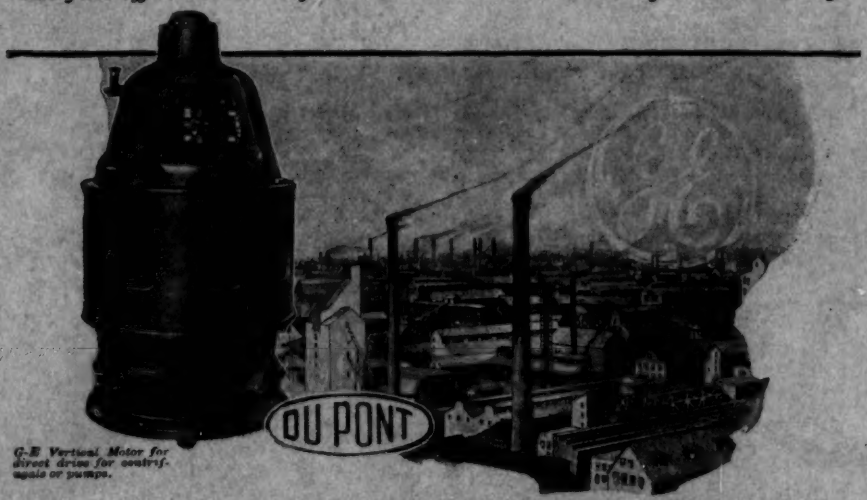
Now is the time to Reciprocate

Those who served you particularly well in the strenuous war-times and post-war-times will certainly appreciate your preference today.

THE HARSHAW FULLER AND GOODWIN CO.

Chicago Cleveland New York
East Liverpool Philadelphia

Nothing but scientifically applied electric power can bring out the full effectiveness of men or machines—so badly needed today



G-E Vertical Motor for direct drive for centrifugals or pumps.

Now industry is adding conservation to production

INDUSTRY throbs with a new energy—the energy to produce, *plus* the energy to conserve.

And as inventions shape the gifts of earth to man's needs, they use power—power made, distributed and used effectively to conserve coal and labor.

For in these times of peace, production must go on; though its cost must be lessened.

* * *

In determining the kind of motors and control which do this great work, there are factors of vital importance. With these factors in mind, G-E engineering specialists co-operate with any concern in finding the way to greater production at lower cost.

In the case of E. I. du Pont de Nemours & Company special motors were found right, and they were built quickly. They increased production and reduced manufacturing cost.

Readiness to serve, and ability to produce just the right electric power equipment, await every user of any kind of power.

Look for this mark of leadership in electrical development and manufacture

GENERAL ELECTRIC COMPANY
SCHENECTADY, N. Y.

48-220

G-E motors

From the Mightiest to the Tiniest

GENERAL ELECTRIC COMPANY